An Overview of the Baseline Data for the Ontario Mineral Industry Cluster Quantitative Assessment

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Ontario Mineral Industry Cluster

PREPARED BY THE

Institute for Competitiveness & Prosperity

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The Ontario Mineral Industry Cluster Council (OMICC) was established in February 2004 to advise on and develop strategy for an effective mineral cluster. The Council's membership comprises representatives from the full range of the mining industry, union, the aboriginal community, environmental groups, academia, suppliers, and all levels of government. (For further information visit OMICC's Web site, www.omicc.ca)

This overview draws from *Baseline for Ontario Mineral Industry Cluster Quantitative Assessment*[1] prepared by The Institute for Policy Analysis at the University of Toronto in August 2005. It presents its key conclusions, identifies its implications for the future development of the mineral industry cluster, sets out further data collection and analysis that would guide the efforts of the Council and assess the Ontario Mineral Industry Cluster (OMIC) against Porter's Diamond Model. A summary of key findings, implications of the Quantitative Assessment for OMICC and specific recommendations for further data collection and analysis are appended to this overview.

The importance and development of clusters

Economists, geographers, and business strategists generally agree that clustering of industries in specific geographic areas is a key driver of regional and national prosperity. Research conducted by Ontario's Institute for Competitiveness & Prosperity indicates that high performing clusters are an important element of strengthening Ontario's prosperity.

Clustering – or agglomeration – refers to the tendency of some industries to mass together in specific locales. While every town above a certain size has a corner store or a law office, steel mills or movie studios are only found in certain areas. Much of this is the result of scale requirements. But scale is not the only reason agglomeration occurs. Historically natural factors, such as mineral reserves and forests, led to resource industries in particular locations. Deep-water ports and rivers created the conditions for certain types of industries to flourish in certain locations. And the presence of highly skilled workers was the driving force for

[1] For a copy of the complete Quantitative assessment contact Colleen Romu, Ontario Ministry of Northern Development and Mines at colleen.romu@ndm.gov.on.ca or 807-475-1606

growth of financial services in London or the fashion industry in Paris. These skills became more and more specialized as the industry clusters developed. Clusters also flourished as firms were driven to improve because of the demands of highly sophisticated customers. London evolved as a world-class insurance centre in no small part because of the significant risk management needs of merchants trading goods throughout the British Empire. Clusters also developed because very capable firms were competing aggressively with one another. As clusters developed, technical innovations have been almost continuous as capable rivals try to outdo one another.

As we look at cluster performance, we see that specialization exists in a limited number of highly related industrial regions and that clusters occur around these specialized industries. Over time these clusters get stronger and develop unassailable advantages. We also see the importance of two complementary structural factors – specialized support and competitive pressure.

Specialized support comes from institutions, skilled workers, suppliers, and others that provide highly focused capabilities that underlay the cluster's strengths. *Competitive pressure* is the result of capable rivals and demanding customers that require firms to continuously upgrade the source and sophistication of their advantage.

The combination of this pressure and support is created by the interaction of the four features illustrated in Michael Porter's groundbreaking book, *The Competitive Advantage of Nations*. Porter drew on his research in ten leading trading nations to show how the traditional bases for countries' competitive advantages – rich natural resources and large labour pools – were no longer sufficient for national or regional prosperity. The best way to assess their competitive position was through the "diamond" which helps organize research and thinking into the four elements that drive cluster performance. The four features of Porter's diamond – demand conditions, rivalry, factor conditions, and related and supporting industries - work together in a self-reinforcing dynamic to drive the clustering of industries.

National, regional, and local governments around the world have drawn on Porter's expertise in international competitiveness and advice on economic development strategies. He also advises corporations on issues of competitive strategy.

In the balance of this document we summarize the findings from the Quantitative Assessment within Porter's framework and set out the implications for OMICC. We discuss:

- The description of the Ontario Mineral Industry Cluster
- Indicators of competitiveness of the Ontario Mineral Industry Cluster
- Findings related to Porter's Diamond

I. Description of the Ontario Mineral Industry Cluster

A key challenge for the authors of the Quantitative Assessment was collecting data across the complete range of industries and organizations in the cluster.[2] Of these, the most readily available information was in the mining sector – the activities most directly related to mining operations. Data availability is a major challenge for assessing much of the value-added activities related to mining. The main source of difficulty is that many suppliers to the mining industry also supply their output to other industries; another source of data collection difficulty is that goods sold to the industry from Ontario may not have been produced here and this breakdown is difficult to collect.

The authors identify two methods to address these data issues. The first method is a survey of companies providing mainly specialized mining products[3]. The second method is to carry out an input-output analysis using Statistics Canada data. Input-output analysis measures linkages between industries and allows for the estimation of upstream and downstream impacts of output changes in specific industries. [4]

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[2] See p. 2 of the Assessment for the schematic of the cluster produced by the Executive Projects Office of the Ministry of Northern Development and Mines. For basic employment and other data the authors drew on Statistics Canada information for "mining (including quarrying)", "services incidental to mining", non-metallic minerals manufacturing", "primary metals manufacturing", and "fabricated metal products manufacturing".

[3] National Resources Canada (NRCan) conducted such a survey in 1998/99 across a sample of 1700 companies. Based on low response rates and low rates of providing all data requested in the survey, NRCan advised caution in interpreting trends over the two years of the survey. The authors do not indicate if the survey contained valuable data for measuring levels rather than trends. (p. 75)

[4] Input-output results are available only at the provincial level. Because of budget limitations, the authors conducted an input-output analysis of the production activities of Ontario mining only. As a result they do not report on the impacts of an increase in other activities such as exploration. The input-output analysis indicates which other industries in Ontario and Canada would be affected by a large-scale increase in Ontario mining (spread proportionately across current mining operations). The authors report impacts on GDP and employment overall and disaggregated to 25 industries and further disaggregated to 300 industries. (pp. 76 – 80 and detailed tables at end of Assessment).

The authors determined the impact on the Ontario and Canadian economy from a $1 billion increase in mining production in Ontario (assuming prices remain constant). This "shock" would increase Ontario's GDP by $818 million in Ontario (See Table 2 in Quantitative Assessment). The full impact of the $1 billion output increase would not be realized because it would cause international imports to increase by $125 million and net imports from the rest of Canada to increase by $55 million.[5] The principal international imports would be machinery and equipment ($34 million), business and computer services ($21 million), chemicals ($11 million), and electric, electronic and communications products ($11 million) (Table 3). These results indicate the opportunity for more value-added products in Ontario's mining cluster – but to understand the magnitude of this opportunity, other input-output analyses would be required.

The $1 billion output shock would create 5,719 new jobs in Ontario. More than half of these jobs, 3,282 or 57 percent, would be created directly in the mining sector. But the finance insurance, real estate, and renting and leasing sector would gain 453 jobs, waste management and remediation services would gain 366 jobs, and professional, scientific, and technical services would gain 305 jobs. Clearly, the mining industry has significant downstream linkages as well. The Assessment makes it clear that these results are only at the provincial level and that further work would be required to detail the linkages in Ontario's Mineral Industry Cluster.

The Assessment has further information based on Canadian Association of Mining Equipment and Services for Export (CAMESE) membership information to present a view of where supply firms are located in the province and the types of services they are providing. These results indicate the importance of Toronto-Mississauga and Sudbury-North Bay as centres of activity in the supply and services firms (pp. 81-88).

Implications for OMICC

The Assessment is a useful first step in describing the elements and linkages of the Ontario Mineral cluster. A full description of these linkages would include:

- Identification of the important upstream and downstream linkages as defined by value added at each stage in the mining and production process. For example, do mining companies have close, ongoing ties with local equipment suppliers or exploration consultants?

[5] The remaining $2 million is accounted for by "inventory leakages" and import duties.

- Some dimension of the size of each of the elements in the cluster – employment or revenue
- Geographic location of the elements inside and outside the province

This description would provide a fact base for the important linkages and where the opportunities for future development of the cluster may lie.

To do this the Council has two options. It can detail the specific information required and commission researchers to carry out the very detailed work required. This would likely be very expensive, perhaps prohibitively so. Alternatively it can take the input-output data and supplier information as provided in the Assessment and draw out the linkages in the cluster through the expert opinion of the Council members or their contacts. This is a simpler approach, although it would still require careful analysis and time commitments of the Council members and an external resource with cluster analysis expertise.

II. Indicators of Competitiveness for the Ontario Mineral Industry Cluster

The report provides several indicators of the competitiveness of Ontario's mineral industry cluster.

It shows Ontario's share of mineral production within Canada

- Ontario leads all provinces in non-fuel mineral production
- It leads in gold, nickel, cobalt, and salt production
- It leads in all facets of structural materials production (pp. 26-27).

Overall, no other province has as much metal production as Ontario.

It shows the share of national employment mineral industry occurring in Ontario (p. 4) and finds there is substantial employment in other Ontario industries directly related to the mining industry, such as non-metallic mineral products manufacturing and primary metals manufacturing. The largest source of employment in the clusters is in **minerals or metals manufacturing** accounting for 90 per cent of cluster employment as defined by the authors**.** These sectors accounted for the cluster's employment growth between 1999 and 2003. Employment in **mining** itself is a relatively small percentage of the total in the cluster. Between 1991 and 2003 mining accounted for less than ten per cent of total employment. Employment in **services incidental to mining** such as contract and test drilling, draining and pumping of mines, and overburden removal increased dramatically between 1999 and 2003 but account for under two per cent of cluster employment. (p. 8)

Within mining, employment has declined since 1994 – from 20,221 in 1994 to 16,545 in 2003. This employment is focused in production, accounting for 67.8 per cent of employment in 2003. This ratio has been fairly constant over the last decade. Employment growth results are mixed in the more knowledge intensive jobs. Employment has grown modestly on a small base in engineering and scientific R&D while it has declined in exploration and administration. (p. 6)

Geographically, about two thirds of mining employment is in Northeastern with the balance nearly split between Northwestern and Southern Ontario. (p. 7) Fully 70 per cent of mining labour income is earned in northeastern Ontario. (p. 20)

Within Ontario, the mining industry employs more people than other natural resource sectors. (p.5)

According to the authors, Ontario's mining industry provides significant and ongoing streams of revenue for all levels of government – in 1993 this amounted to $264 million. However, the report does not compare these tax revenues to other leading industries on an absolute or relative (e.g., per employee or per revenue dollar) basis. (p. 21)

Input/Output analysis indicates that Ontario's mining sector has important linkages to all sectors in Ontario. The authors estimate that a $1 billion increase in mining output in Ontario would increase employment by 5, 719 in the province and by 551 elsewhere in Canada. As expected the main impact would be in mining itself – about 57 percent of total employment impact in the province. Spillovers to other sectors would account the remaining 43 per cent – finance, insurance and leasing (8 per cent), waste and remediation (6 per cent), professional, scientific, and technical services (5 per cent), and all others (21 per cent) (p. 80).

Average wages in the mining sector are significantly higher than in the rest of Ontario. At $1,092, average weekly earnings in mining for 2003 were 49 per cent higher than across all Ontario sectors. These earnings are higher than other important resource sectors, pulp, paper & paperboard and logging & forestry. They are also higher than manufacturing and construction. In addition wages in the other parts of the mining cluster – services incidental to mining and oil & gas, primary metals manufacturing, non-metallic minerals manufacturing, and fabricated metal products – are above average for all Ontario sectors. (pp. 15-17)

In total, wages and salaries amounted to more than $9.5 billion in 2003. (p. 18) Benefits accruing to Ontario mining industry employees are a significant share of total labour income – accounting for 34.8 percent of labour cost in 2003. (p. 19)

Industry growth. The industry is experiencing only modest revenue growth, according to Datametrics Consulting Inc./University of Toronto survey of the mining industry. The revenue trend over the decade 1994 – 2003 was essentially flat. (p. 101)

Exports of metal ores have been growing significantly since 1999 from about $2 billion to $2.6 billion in 2003. Ontario's annual balance of international trade in metal ores has been above $1 billion through the last decade and reached $1.9 billion in 2003. (p.29)

Non-metal firms are more dependent on domestic markets according to the authors. However exports reached $300 million in 2003 up from under $200 million in 1994. The balance of international trade reached $100 million in 2003 – up from the $30 million range for most of the last decade. (p.30)

In value-added areas the export record is mixed:

- Ontario achieves an international trade surplus in *metal manufacturing* reaching $800 million in 2003
- However, in *fabricated metal product manufacturing*, Ontario's international deficit reached $4 billion in 2003, a mild improvement over the results achieved in 1998 – 2002
- Ontario's *non-metallic manufactured products* typically realize a trade deficit and in 2003 this stood at over $1.1 billion
- In *mining and oil & gas field machinery* imports and exports are much less than in the afore-mentioned materials. In 2003 Ontario achieved a modest surplus of just under $40 million; through the last decade Ontario has moved between deficit and surplus
- In *manufactured explosives*, Ontario has typically achieved an international trade surplus over the last decade, although in 2003 the trade balance was roughly zero. (pp. 31-36)

The authors report detailed data for commodity categories that have been identified as inputs to the cluster. With the caveat that the international trade in these industries cannot be associated uniquely with the mining industry, the following have the most significant net import balances in 2004:

- Reciprocating piston engines for road or off-highway motor vehicles – displacing over 1,000 cc ($1,465 million)
- Diesel engines for road or off-highway motor vehicles ($953 million)
- Taps, cocks, valves and similar appliances for pipes, boiler shells, tanks, vats, and the like ($779 million)

- Pumps for liquids; liquid elevators ($513 million)
- Transmission shafts and cranks; bearing housings, gears and gearings, flywheels and pulleys ($373 million)
- Prepared binders for foundry moulds/cores; other chemical products and preparations ($133 million)
- New pneumatic rubber tires – for buses or trucks ($119 million)

Only trucks of various ignition types and load capacities had export balances greater than $100 million ($3,108 million) (pp. 37-43).

The authors report on the number of US patents registered by the mining cluster; however as they do not compare these results with other countries it is difficult to determine if the results presented are strong or weak (p. 53).

Implications for OMICC

The assessment contains much useful information on the economic importance of Ontario's mineral industry cluster and situates it in the Canadian context. Two other sets of analyses would be useful.

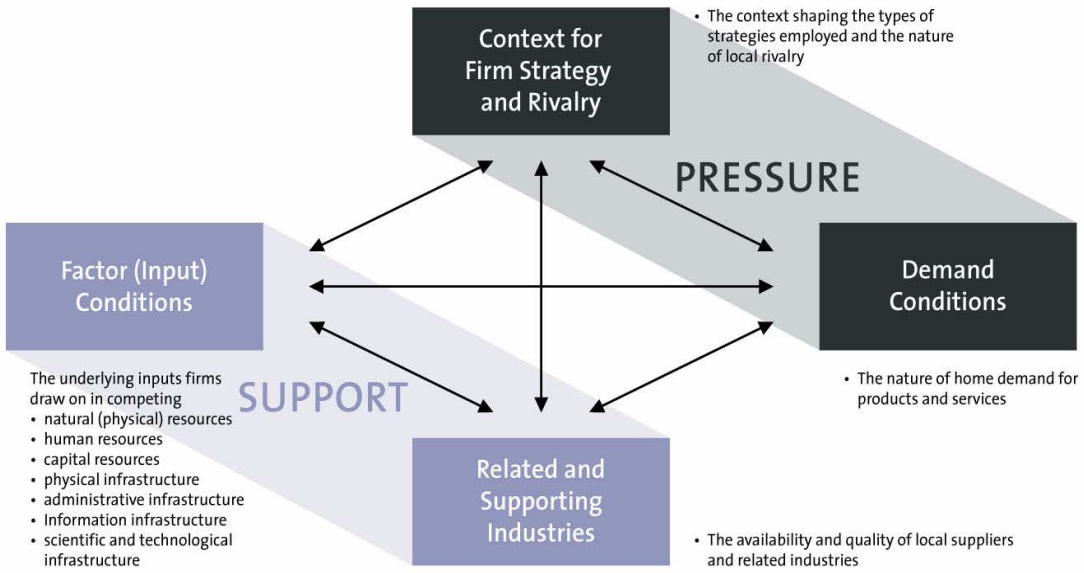
First, the Assessment provides a baseline of information on where there may be export or import replacement opportunities. The Council needs to determine which of these appear most significant and carry out focused, detailed research into these categories. It needs to develop a clear understanding of the magnitude of import replacement opportunities and the barriers to realizing them. Further research would narrow down a long list to a handful of significant opportunities fro more detailed follow up.

Second, the Council could deepen its understanding of other world-class mineral industry clusters. The Assessment reviews three other clusters based on information provided by the Institute of Northern Ontario Research and Development at Laurentian University (pp. 91 – 94). Further research would be useful in determining how well these clusters have developed their linkages, particularly in added value service and equipment and their success in cluster development initiatives. It is possible that these clusters, as strong as they are, have little that is useful to learn for Ontario. Other clusters that may be worth examining would be the mining machinery cluster in Sweden and elsewhere as well as other resource-based clusters outside of mining.

III. Findings related to Porter's Diamond model

In this section we review the Assessment's findings that relate to Porter's diamond model. For each of the four elements of the diamond model, we briefly summarize Porter's research conclusions, review the relevant findings from the Quantitative Assessment, and discuss the implications for future OMICC work.

Pressure and Support in Michael Porter's Diamond



Source: Porter, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School; Institute for Competitiveness & Prosperity

Porter's Diamond – Factor Conditions

Factor conditions are the necessary support base for any cluster. "The factors most important to competitive advantage in most industries, especially the industries most vital to productivity growth in advanced economies, are not inherited but are created within a nation… thus the stock of factors at any particular time is less important than the rate at which they are created, upgraded, and made more specialized to particular industries". Porter sets out five input factors that are important to the strength of clusters:

- *Physical resources*, which includes the abundance of relevant natural resources as well as location relative to markets and supplier bases

- *Human resources*, the quality and skill of workers and managers

- *Knowledge resources*, the stock of scientific, technical and market knowledge of relevance to the cluster. This specialized knowledge typically resides in universities and colleges, public and private research institutes, trade associations, participating competitors, and other sources.

- *Capital resources* which make financial resources available for investing in the cluster. Capital has become quite globally available; but some clusters have unique capital needs that can results in different capital vehicles being developed locally.

- *Infrastructure* which affects the quality and cost of product and service delivery as well as the quality of life for people working in the cluster.

Porter stresses the distinction between basic, inherited factors and more sophisticated, developed factors. Advantage from the former may not be sustainable as the factors is depleted (e.g., mineral resources) or as competitors match them (basic engineering capability). The challenge facing any cluster is to build value-added factors which are not easily copied elsewhere and are highly specialized to meet the needs of the cluster.

Porter also argues that ongoing investments in upgrading factor conditions are an important key to success of a cluster. Both the public and private sectors have roles to play in factor development. Government investment should focus on the more basic and general factors. These include infrastructure, basic education and skills development, and streamlined regulatory and administrative procedures. Private sector participants must be investing in the specialized factors because they are closer to the market and is faster in decision making. These investments include machinery and equipment, specialized knowledge and skills in collaboration with local universities and colleges, and tailored capital vehicles for raising debt and equity.

The Quantitative Assessment and Factor Conditions

The Assessment does not discuss the natural factors that cause the cluster to be in existence – i.e., the richness and accessibility of deposits, although the Assessment indicates that natural resource endowment is a reason for productivity growth.

The Assessment reports on the high value added per employee in the Ontario mining industry – at $239 thousand per employee in 2002 it was among the highest of any industry in the province (p. 44). Growth in labour productivity

has been very impressive - between 1997 and 2003 it grew by a stellar 42 per cent. In comparison, productivity growth over the same period in manufacturing was 16 per cent. The authors cite three reasons for this productivity performance – high capital investment, efficient technology, and Ontario's unique endowment of natural resources (p. 45).

An important factor advantage is the environment of safety in mining. According to the authors, Ontario is considered to be the safest mining jurisdiction in Canada. They cite statistics related to injuries and review legislation, regulations, and industry efforts that set high safety standards (pp. 11-14).

Another key factor input to a successful cluster is the availability of local stock markets that are open to new and medium-sized firms. The authors describe the importance of the Toronto Stock Exchange (TSX) and the TSX Venture Exchange and indicate their important role in initial public offerings and subsequent financing for supporting R&D, exploration, and mine development. The TSX and TSX Venture Exchanges are also important exchanges for financing mining companies and mining projects around the world (pp. 70-72).

The cluster has benefited from buoyant prices in important metals, such as copper, nickel, gold, platinum, and zinc – and these price increases are likely contributing to the increased value added per employee.

An important input factor to mining industry is electricity. According to the authors, Ontario's mining industry accounted for 7.4 per cent of total industrial demand for electricity in the province in 2003. When industries related to mining – iron & steel, aluminum & non-ferrous, and cement - are included they account for 29.4 per cent of demand. Natural gas, the other significant source of energy in the industry is becoming more important. Thus the increases in electricity and natural gas pricing as well as the uncertainty of electricity supply represent significant challenges to the mining cluster's competitiveness. (pp. 46-48).

In human resources, mining employment is fairly stable as we have seen and there has not been significant recent growth in the employment of specialized skills in exploration and R&D (pp.6-10).

The cluster benefits from industry-specific knowledge and scientific infrastructure.

In research and development, the authors conclude that spending on r&d has enhanced the competitive position of the industry. According to the Datametrics Inc./University of Toronto survey, the mining industry spent $30 to $70 million

annually on r&d over the 1994 -2003 period. Statistics Canada reports that the metals and non-metallic mineral industries spent $138 million on R&D in 2002. The authors also show that this R&D is undertaken by a wide variety of firms in all facets of the cluster (pp.49 – 51).

The authors report on the amount of R&D being conducted in higher education in natural sciences and engineering. This has doubled between 1996-7 and 2002-3 and in 2002-3 total R&D spending in higher education stood at $1.2 billion in Ontario. The authors identify some of the key organizations dedicated to mining research or its commercialization. (pp. 49-58).

There is a wide range of development agencies playing a key role in securing financing for the industry. The report identifies a full range of agencies in place to provide funding for Aboriginal entrepreneurs and the broader range of economic development needs of Northern Ontario (pp.95–98).

The report identifies the significance of the mineral industry cluster to rail and water transport. While they do not address the issue directly it can be inferred that the cluster benefits from a good transportation infrastructure (pp. 89-90).

Implications for OMICC

The paper identifies the strength of the factor conditions that underlie this cluster. To ensure the ongoing strength of the cluster, it will require ongoing attention to the development of

- *Physical resources*. The cluster benefits from world-class mineral reserves; ongoing exploration and development will be a necessary to ensure development and replenishment of these reserves

- *Human resources.* The strength of the cluster will depend on specialized human resources and some research into the skill needs and how to meet these should be undertaken. The paper indicates that skills requirements have not been upgraded significantly in the past decade; this may be a fruitful area for deeper research to understand the reasons why and the implications for the future strength of the cluster.

- *Knowledge resources*. The report identifies significant R&D activities being carried out in the cluster. The Institute for Competitiveness & Prosperity has identified the importance of management training in the development of Ontario's innovative capacity. Developing a clearer understanding of the needs in management education for the cluster may be helpful.

- *Capital resources.* The paper identifies the sophistication of the financial markets supporting the cluster. Further analysis is required to determine if this financial know-how strength can be marketed outside of Canada

- *Infrastructure.* The paper implies that the cluster is benefiting from good infrastructure. OMICC may want to confirm that new infrastructure investments are not critical requirements for the future development of the cluster.

Porter's Diamond - Demand Conditions

Porter's research indicates that the quality of local demand is a critical determinant of a cluster's strength. Clusters gain advantage if home buyers pressure them to be more innovative and sophisticated in their basis of competition. He addresses the widespread view that globalization of competition renders local demand as less and less important. The benefits of local demand include:

- People and firms naturally pay more attention to nearby needs and to the extent that local demand is sophisticated this will drive the cluster to succeed globally

- Local communication is of higher quality than remote communication. Frequent face-to-face communication strengthens understanding of market needs and forms a more intuitive understanding of customer needs

- When market signals from home and foreign markets diverge, signals from the home market typically dominate.

Market segments are more important than the broad market. Market segments can be defined by geography (e.g., different climates require different corrosion resistance in steel), customers (e.g., integrated steelmakers require different types of minerals than mini-mills), and other ways. Porter's research indicates that clusters develop better when they are built around specific segments in the home market. Building strengths in specific segments can give cluster participants unique advantages that are difficult to copy. A cluster's firms are likely to gain competitive advantage in global segments that represent a large share of home demand but account for a less significant share in other nations. Local firms will have the opportunity – and the pressure – to develop world-leading capabilities in this segment and gain advantage in this segment around the world. This can be helpful to cluster development in nations with a small home market. Porter

refers to the advantage sustained by Swedish firms in equipment and rock drills for mining in very hard rock, the dominant geology encountered in Swedish mining. This is in contrast to the lead held by US firms in rotary mining equipment, used principally for oil and gas exploration and production – the dominant segment in the United States.

The other key dimension in identifying segments is the sophistication of the buyers in the segment. Sophisticated and demanding buyers pressure cluster participants to innovate. If these buyers' needs anticipate demand patterns globally, a globally competitive cluster will be more likely.

Rate of growth in local demand is also important. Rapidly growing markets or segments lead firms to adopt more up-to-date technology and to invest in new products and new facilities. Growing demand for wireless communications, for example, drives product advances, such as the Blackberry and new investments in information and communications technology as is the case in the Waterloo and Ottawa technology clusters.

The challenge and the opportunity for small clusters in small countries is to isolate the segment of demand in their home market which will stimulate world-class capabilities in that segment. As we saw earlier, Swedish machinery and equipment firms built a global advantage from meeting the requirements of hard rock mining operations.

The Quantitative Assessment and Demand Conditions

The Assessment does not discuss in detail the level of sophistication of the cluster's customers and whether or not they are stimulating innovation in the cluster.

One factor in determining the sophistication of demand is the type of regulatory standards and whether they trigger or stifle innovation. As we discussed earlier, Ontario has very stringent safety standards. However, the Assessment does not indicate whether this has spurred on innovation in the industry – and whether there are export opportunities to less sophisticated mining clusters.

Implications for OMICC

The real challenge for the development of this cluster is the development of sophisticated demand that draws on the unique conditions of this cluster. For example:

- Are there meaningful ways in which local customers for mining output are demanding and sophisticated? Or do the mines simply sell in to global commodity markets?

- Are there opportunities for mining operations in northern Ontario to develop capabilities that result from the minerals and the geology in northern Ontario – capabilities that are meaningful in other parts of the world?

- What unique factors of the geology in northern Ontario have relevance to the development of mining equipment to serve this cluster and create export markets?

Based on Porter's research, these questions probably represent the most significant challenges to the development of the mineral cluster. Without demanding and sophisticated customers, the cluster will not feel the pressure so necessary for innovation.

Porter's Diamond - Related and Supporting Industries

A cluster's success depends on the support it receives from suppliers and related industries. Strong local suppliers are important supporters in the process of innovation and upgrading. Porter identifies several clusters where competitive advantage emerges from the local interplay of highly capable suppliers and industry participants. As with the importance of local buyers, local suppliers make interaction more efficient and effective. But the cluster receives maximum benefit if local suppliers are themselves global competitors. Home-based suppliers with international positions are more valuable providers of information and insight. Porter points out that a cluster does not need to have advantage for all inputs. Instead "inputs without a significant effect on innovation or on the performance of an industry's products and processes can be readily sourced from abroad". (p.104)

Similarly clusters benefit from capable firms in related industries. Related industries can share in developing technology, manufacturing, distribution, and service. Porter cites the example from Sweden of Atlas Copco (mining

machinery) and Sandvik (rock drills) who have a history of collaboration in several areas.

The Quantitative Assessment and Related and Supporting Industries

As discussed above, the cluster has some significant trade deficits in key supply elements:

- Mining and oil and gas field machinery, although this has turned into a surplus since 2001
- Engines for off-road vehicles
- Taps, cocks, valves and similar appliances for pipes, boiler shells, tanks, vats, etc
- Pumps for liquids and liquid elevators
- Transmission shafts and cranks; bearing housings, gears and gearings, flywheels and pulleys

The authors do point out that the data in their analysis are not necessarily related to the mining industry although some of the items discussed are most likely supplies to the cluster. As discussed above, this would be a useful avenue for greater research to determine the extent of the mining machinery opportunity and what barriers exist to the development of this opportunity.

The authors also indicate that the cluster "paid more for foreign technological services (R&D and other) than it sold abroad." Statistics Canada reports that in 2002 all Canadian industries received $775 million more in receipts from abroad for technological services than it paid out. However, the mining and oil & gas extraction industry had a deficit of $29 million (p. 52). Again, the authors point out that these results are for a very broad industry definition and that the extent of technology imports and exports in Ontario's mineral industry may not be accurately described by these results.

Implications for OMICC

If the cluster is to identify real opportunities for home-grown suppliers of sophisticated equipment and services, it will require much more specific information on what is currently being imported and where opportunities for displacement exist. This will require:

- a serious effort at identifying specific imports to the cluster
- a through understanding of the barriers to developing a home-grown supply base
- a realistic assessment of how successful a new entrant would be, including an articulation of the sustainable competitive advantage it would have
- an identification of roles by the public and private sectors in realizing this opportunity.

Porter's Diamond - Firm Strategy and Rivalry

The final element of Porter's diamond is the impact of local rivalry in pressuring cluster participants to innovate. In his research he found that world-class clusters often have many strong local rivals, even in small countries. This is observed in world-class clusters in small countries like pharmaceuticals in Switzerland and automotive in Sweden. Domestic rivalry is more important than global rivalry because it is more visible and is based on emotional factors (pride, bragging rights) as well as economic ones. In global competition successful firms compete vigorously in the local market pressuring each other to upgrade. Scale economies are achieved by selling to the global market, but the spark of local competition ignites success around the world.

The Quantitative Assessment and Firm Strategy and Rivalry

Porter sets our four elements of rivalry: competition based on innovation, co-operation on matters that are beneficial to the industry, the uniqueness of local competitive strategies, and the attractiveness of the local investment context.

Competition. There is evidence that the competitors in the mineral cluster are competing on the basis of innovation – one of the signs of a healthy cluster.

According to the Datametrics Consulting Inc./University of Toronto survey competitors in the mining industry spends between $30 and $70 million annually in r&d. Statistics Canada reports that the non-metallic mineral products, primary metals, and fabricated metals industries spent $138 million in 2002. The authors note discrepancies between the two sources.

According to the Mining Association of Canada (MAC), large mining companies are more likely to engage in R&D in house because they have the advantage of economies of scale and access to global markets. Five integrated mining companies are in the top 100 private sector R&D investors. (p. 49)

The authors also report data from Statistics Canada that show that "R&D takes place across a wide spectrum of the mineral industry and its suppliers and customers". (pp. 50-51)

Authors summarize three other mining clusters around the world. (pp. 91- 4) More could be done here to measure Ontario's cluster with other world-class clusters.

Co-operation. The authors also set out the various elements of co-operation between firms in the cluster. It describes Laurentian University's Mining Innovation, Rehabilitation and Applied Research Corporation (MIRARCO) and the role played by Goldcorp and Placer Dome in developing it. Other entities which represent collaborative efforts by cluster participants discussed in the report include Contact North, Laurentian University Mining Automation Laboratory (LUMAL), Northern Centre for Advanced Technology (NORCAT), Ontario Research and Innovation Optical Network (ORION), Mineral Exploration research centre (MERC), the Canada Centre for Mineral and Energy Technology (CANMET), the Centre in Mining and Mineral Exploration Research (CIMMER) (pp. 54–58).

Unique local strategies. As discussed above, the mining sector has performed well in productivity, or value added per employee, performance. The authors attribute this success to the "mining industry's capital-intensive nature, and to its high skill requirements" (pp. 44–45). This suggests innovative strategies by mining firms, but specific strategies in the cluster are beyond the scope of the paper. Future research into the uniqueness of local strategies would be helpful in assessing the depth of the cluster. It would be helpful to understand how much of the value-added performance is because of high commodity prices and how much is because of innovative strategies.

As discussed earlier there are several co-operative efforts in the industry to enhance firms' strategies and operations.

Local investment context. The mining industry benefits from a tax environment that encourages mining exploration. The paper reviews the benefits of flow-through shares whereby the federal and provincial governments offer enhanced deductions for purchasers of flow-through shares of junior mining companies. The Province has added incentives to flow-through shares by offering eligible individual shareholders a bonus deduction, in addition to the 100 percent currently available, in respect of eligible corporate exploration expenses. The authors indicate that this program has been very successful in generating exploration investment funds for mineral exploration. The report includes a map

that shows the source of funds as being southern Ontario while the expenditures have been in the north. (p. 59)

The report also includes a long list of government incentive programs, although most of these support all industries – or industries other than mining. (p. 98)

Implications for OMICC

By its very nature, OMICC will focus in areas of industry co-operation rather than rivalry. But it may be useful to determine the intensity of competition between the various elements of the cluster – mining operations, equipment and services suppliers, and providers of financing. This assessment would identify how much of the competition among local firms was on the basis of innovation versus price. The analysis could go further to determine whether such innovations in the local market led to export outside the cluster.

On the co-operation side, it would be useful to set out the common challenges facing the cluster that can be solved jointly. These would include skills development, especially in the management ranks, infrastructure requirements, and basic R&D. Undoubtedly many of these initiatives are underway though other processes. The Council needs to ensure it is aware of these initiatives and is providing direction to them.

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The Quantitative Assessment is a preliminary compilation and assessment of data on the Ontario Mineral Industry Cluster. It provides a baseline of information that is necessary for the more detailed and focused analysis identified in this summary. It can also guide future research efforts in identifying high potential research efforts. The Assessment identifies the significant data collection challenges in the cluster, which in many cases are insurmountable – thus highlighting the next steps in clearly articulating research needs and data collection and analysis plan.

Key Findings in the Quantitative Assessment

- The $1 billion output shock [in the input-output analysis] would create 5,719 new jobs in Ontario. More than half of these jobs, 3,282 or 57 percent, would be created directly in the mining sector.

- [The] results indicate the importance of Toronto-Mississauga and Sudbury-North Bay as centres of activity in the supply and services firms (pp. 81-88 in the Quantitative Assessment).

- The largest source of employment in the clusters is in **minerals or metals manufacturing** accounting for 90 per cent of cluster employment as defined by the authors**.**

- Geographically, about two thirds of mining employment is in Northeastern with the balance nearly split between Northwestern and Southern Ontario. (p. 7) Fully 70 per cent of mining labour income is earned in northeastern Ontario. (p. 20)

- Average wages in the mining sector are significantly higher than in the rest of Ontario. At $1,092, average weekly earnings in mining for 2003 were 49 per cent higher than across all Ontario sectors.

- The Assessment reports on the high value added per employee in the Ontario mining industry – at $239 thousand per employee in 2002 it was among the highest of any industry in the province (p. 44).

- An important factor advantage is the environment of safety in mining. According to the authors, Ontario is considered to be the safest mining jurisdiction in Canada. They cite statistics related to injuries and review legislation, regulations, and industry efforts that set high safety standards (pp. 11-14).

Summary of Implications for OMICC

Description of the Cluster

The Assessment is a useful first step in describing the elements and linkages of the Ontario Mineral cluster. OMICC should identify and assess the important upstream and downstream linkages at the various stages of the mining and production process. This will help identify opportunities for strengthening the cluster.

Indicators of Competitiveness

The assessment contains much useful information on the economic importance of Ontario's mineral industry cluster and situates it in the Canadian context. Two other sets of analyses would be useful. OMICC should identify priorities for which export or import replacement opportunities should be assessed further. It should deepen its understanding of other world-class mineral industry clusters.

Porter's Diamond – Factor Conditions

The paper identifies the strength of the factor conditions that underlie this cluster. To ensure the ongoing strength of the cluster, MMICC needs to ensure that the ongoing development and replenishment of reserves and infrastructure – which appear to be strengths of the cluster. It should determine key gaps in technical and management skills. It should explore opportunities for exporting cluster-specific financial know-how.

Porter's Diamond – Demand Conditions

The real challenge for the development of this cluster is the development of sophisticated demand that draws on the unique conditions of this cluster. OMICC should explore unique factors of this cluster, e.g., local customer differences, the geology, and specialized equipment, which are seen to drive innovation in this cluster – and which present opportunities for international expansion.

Porter's Diamond – Related and Supporting Industries

If the cluster is to identify real opportunities for home-grown suppliers of sophisticated equipment and services, it will require much more specific information on what is currently being imported and where opportunities for

displacement exist. This will require more data on imports and a structured assessment of how local players could realize these opportunities.

Porter's Diamond – Firm Strategy and Rivalry

By its very nature the Mineral Industry Cluster will focus in areas of industry co-operation rather than rivalry. But it may be useful to determine the intensity of competition between the various elements of the cluster – mining operations, equipment and services suppliers, and providers of financing. This assessment would identify how much of the competition among local firms was on the basis of innovation versus price. The analysis could go further to determine whether such innovations in the local market led to export outside the cluster.

On the co-operation side, it would be useful to set out the common challenges facing the cluster that can be solved jointly. These would include skills development, especially in the management ranks, infrastructure requirements, and basic R&D. Undoubtedly many of these initiatives are underway though other processes. The Council needs to ensure it is aware of these initiatives and is providing direction to them.

Opportunities for Further Data Collection and Analysis

- These results indicate the opportunity for more value-added products in Ontario's mining cluster – but to understand the magnitude of this opportunity, other input-output analyses would be required. Detailed information on upstream and downstream linkages could be collected through means other than input-output analyses.

- The authors do point out that the data in their analysis are not necessarily related to the mining industry although some of the items discussed are most likely supplies to the cluster. …this would be a useful avenue for greater research to determine the extent of the mining machinery opportunity and what barriers exist to the development of this opportunity.

- However, the report does not compare these tax revenues to other leading industries on an absolute or relative (e.g., per employee or per revenue dollar) basis. (p. 21)

- The authors report on the number of US patents registered by the mining cluster; however as they do not compare these results with other countries it is difficult to determine if the results presented are strong or weak (p. 53).

- The Assessment reviews three other clusters based on information provided by the Institute of Northern Ontario Research and Development at Laurentian University (pp. 91 – 94). Further research would be useful in determining how well these clusters have developed their linkages, particularly in added value service and equipment and their success in cluster development initiatives.

- The paper indicates that skills requirements have not been upgraded significantly in the past decade; this may be a fruitful area for deeper research to understand the reasons why and the implications for the future strength of the cluster.

- The Institute for Competitiveness & Prosperity has identified the importance of management training in the development of Ontario's innovative capacity. Developing a clearer understanding of the needs in management education for the cluster may be helpful.