

## **Mining Clusters and Local Economic Development in Latin America**

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### I. Concepts and issues in the research on mining clusters

#### 1. Introduction: the ECLAC/IDRC research project on mining clusters

Is a development strategy conceivable for Latin America that has the region's abundant natural resource base as its point of departure? What would such a development strategy look like and what would be its environmental and social consequences? With these questions Joseph Ramos initiated at ECLAC a research program on natural-resource based clusters. The cluster approach was considered adequate because of the assumption that Latin America could not attain development by exporting commodities. The challenge seems to be to foster economic activities related to the exploitation of natural resources, through forward, backward or lateral linkages.

One of the natural resources identified for analysis were minerals. In this case, the ECLAC research program joined efforts with Canada's International Development Research Center (IDRC). The Canadian sponsoring of case studies was very fitting because that country's development sprang from the exploitation of its natural resources, among which its mineral base. The example of Canada's mining cluster is a very relevant one and IDRC has been sponsoring various research programs in that field, most importantly the Mining Policy Research Initiative.

Mining is an excellent field of study to analyze the relation between natural resource endowments and development in Latin America. The region holds a significant share of the world's mineral resources and production. Mining is in several countries a major economic activity with a significant contribution to exports. In some areas the local economy depends almost exclusively on mining. On the other hand, mining historically does not seem to have contributed much to employment generation and the establishment of production linkages. The activity requires more than most others, an adequate management of environmental issues for sustainable development. The contribution of mining to development in Latin America depends crucially on the success of the management of its social and environmental impact.

The tensions between the three dimensions of sustainable development, i.e. economic, social and environmental, are particularly evident in the mining sector in Latin America. Its management requires an adequate working relationship between different groups of agents from the private, public, academic and social sectors. This is all the more evident at the regional and local level in those places where mining is the most important economic activity. In these places local Governments, business organizations, local universities and non-governmental organizations are actively searching for new ways to manage the challenges. This also relates to the tendency in Latin America that those agents have an increasing role in the design and implementation of development strategies. The collection of case studies elaborated in the ECLAC/IDRC project on mining clusters in Latin America explores how different groups of agents interact to improve the competitiveness of the mining business on which all depend, and to improve the social and environmental performance of the mining activity.

This paper is the summary of the ECLAC/IDRC research project on Mining Clusters also published in the book "Aglomeraciones Mineras y Desarrollo Local"<sup>1</sup>. The project consisted of a dozen case studies prepared between early 1999 and the end of 2000. The case studies were discussed in an international conference in Santiago de Chile, November 2000. The papers, the book and the conference were not the only goals of the project. It should have practical results as well as a good publication. The main goal was to provide people, be they in public, private, academic or social roles, with a better understanding of the factors that affect economic, social and environmental perspectives of mining in their locality, so as to

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<sup>1</sup> Buitelaar, R. (2001), *Aglomeraciones Mineras y Desarrollo Local en América Latina*, CEPAL/IDRC/Alfaomega, Bogotá

contribute to improve the design and implementation of concerted interventions. The book and this paper aims to be instrumental in that regard.

This paper starts with an outline of the main arguments regarding the relation between natural resource abundance, in particular of mineral resources, and development. There are several theoretical arguments as to why natural resource abundance not necessarily conduces to sustainable development. All these arguments have to do with the relation between groups of agents around the mining sector in a particular place. This is the object of study that we call here “clusters”. Our interpretation of this concept and how it helps to analyze the research questions will be explained. The conceptual introduction leads to the hypothesis underlying the project: the contribution of mining to development depends on the type and the quality of interaction among agents involved. This hypothesis is explored in the case studies from different angles. This paper will explain the different approaches used in the different case-studies and how they relate to the central questions in the project. The paper will highlight the findings of the different case-studies and present the overall conclusions.

## 2. The paradox of impoverishing abundance

Its natural resource endowment does not seem to have allowed Latin America over the past couple of centuries to attain a satisfactory economic and social performance. The question is whether there is a causal relation between natural resource abundance and economic performance. The natural resource curse thesis that holds that natural resource abundance is the cause of lesser economic growth has been explored in econometric research<sup>2</sup>. Different conclusions have been reached. Sachs and Warner find the growth rate of GNP to be negatively correlated to different measures of natural resource abundance in a sample of 97 countries, using time series data covering a 20-year period. They conclude that this correlation cannot be attributed to coincidence and therefore there has to be something in the endowment itself that explains insatisfactory development. Davis, on his part, develops a Mining Dependency Index for 91 countries and correlates it to an ample group of economic and social development measures. His conclusion is that it is difficult to sustain that countries with more mineral resources have done less well in economic and social terms than countries with less mineral resources.

These are only two examples of an ample literature that illustrates the difficulties in specifying correctly the relevant variables. Different specifications produce opposing results, but the authors in general reach quite similar conclusions. The causal relation involves the dimension of economic policies. It is not the natural resource endowment per sé but the wrong economic policies that explain the lesser economic development. It therefore has to be possible to design adequate economic policies given the specific resource endowment. Important welfare gains must be obtainable through adequate policies in these situations.

In order to say a bit more about what would be an adequate set of policies it is necessary to explore further the supposed causality in the relation between natural resources and economic performance. The economic literature suggests three lines of causality. There are also extra-economic hypothesis, but here we concentrate on the economic arguments.

The first argument is very close to the history of ECLAC. Demand for primary products increases less than demand for services and manufactured goods as income increases. The evidence for the Prebisch-Singer thesis is sometimes disputed but the economic reasoning is very solid and the argument maintains its validity fifty years after its introduction. The consequence is that economies that specialize in exports of primary products have a less dynamic demand and will therefore grow at a lower rate than economies with other export specialization. Prebisch and ECLAC recommended to foster manufacturing industry to generate a different kind of export structure. Nascent industries would require a guaranteed market with attractive profitability and therefore the import-substitution regime was implemented. The anti-export bias

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<sup>2</sup> E.g. Sachs and Warner (1995) *Natural Resource Abundance and Economic Growth*, Development Discussion Paper 517a, Harvard Institute for International Development; Gavin and Hausman (1998), “Nature, Development and Distribution in Latin America: Evidence on the Role of Geography, Climate and Natural Resources”, IDB, Office of the Chief Economist Working Paper 378; Altamirano (2000) *Essays on mining countries: Dutch Disease, Development and Copper Markets*, unpublished PhD thesis, University of California, San Diego; Davis, G. (1995), *Learning to Love the Dutch Disease: Evidence from the Mineral Economies*, *World Development* vol. 23 no.10

implicit in the regime generally speaking and most clearly in the small economies, hindered the intended change of specialization. The diagnosis seemed adequate but the recommended policies did not work as intended.

Hirschman<sup>3</sup> presented in the fifties a different argument but coincided with Prebisch in its conclusion regarding the convenience to foster manufacturing industries and in its policy recommendations. He introduced the concept of linkages as a central explanatory element of the development process itself. In his original vision, linkage is the force with which certain investments induce other, related investments. Some are weak at inducing other investments or activities and therefore will not generate development to the same extent as other investments that have a stronger inducement force. This explanation of development pertains to a group of similar ideas among which Hirschman mentions the Big Push of Rosenstein-Rodan, Rostow's take-off triggered by the "leading sector", Gerschenkron's "great sting" or the minimal critical effort of Leibenstein. The explanation of development proposed by Hirschman coincided with the idea that development is intrinsic to the manufacturing sector much more than it is to agriculture or mining.

Unfortunately, two circumstances reduced the original proposition of Hirschman to a mechanical approach to development policies. The first refers to the then recent availability of input-output matrixes, that allowed the linkage approach to become empirically operational. In the process, the concept was reduced to the intensity of buyer-supplier relations within and among economic sectors as defined by the also novel national account systems. The second circumstance was the policy of development planning in the import substitution strategy, by which the analysis of input-output linkages was used to establish priorities regarding public investment in those sectors that showed stronger linkages.

It would be a mistake to discard the ideas of Hirschman together with the planification instruments of old and the import substitution strategy. Hirschman himself made his linkage concept more complex and distanced from superficial operativization. He introduced, for example, consumption linkages, which are the force by which the increase in the consumption of imported products after income increases due to primary exports induce investments in local capacity to produce precisely those imported products. Ironically, consumption linkages would explain how manufacturing industry may come about because of agricultural or mining exports. In 1987 his linkage concept turned out to be much more general and interpretative and less operational, related to the type of economic, social and political development arising from the constellation of linkages in an economy, using the concept to explain the complex interaction between technology, ideology, institutions and development.

A modern and more dynamic argument to sustain the thesis of a natural resource curse is that manufacturing industry contains more learning effects that would impulse the rest of the economy into a steeper productivity curve. An economy specialized in primary products would therefore benefit less from externalities inherent in manufacturing production.<sup>4</sup> The ECLAC manifesto of 1990 contains another expression of this argument. Based on the works of the late Fajnzylber<sup>5</sup>, ECLAC argues that technical progress and the acceleration of productivity increases are keys to economic development and improvements of living standards, and that they are contained in high technology sectors and manufacturing industry not based on natural resources. The conclusion was that Latin America will not attain a satisfactory growth rate if it does not develop endogenous technological capabilities in new industries and does not create an export capacity in technology-intensive manufacturing sectors.

The most concrete policy recommendation was to invest in research and technological development and to foster knowledge-intensive sectors. In practice, Latin America in the 1990s does not show many examples of this kind of policy priorities. Maybe the effort to attract foreign direct investment in microelectronic assembly operations as in Mexico and Costa Rica constitutes a watered down version of this approach. These assembly operations may be very important for job creation but do not seem to have generated

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<sup>3</sup> Hirschman (1957) *The Strategy of Economic Development*, New Haven, Yale University Press, and (1977) *A generalized linkage approach to development with special reference to staples*, *Essays on Economic Development and Cultural Change* in honor of Bert Hoselitz, vol.25, supplement, University of Chicago Press, Chicago

<sup>4</sup> see e.g. Sachs and Warner (1995)

<sup>5</sup> Fajnzylber, F. (1990). *Industrialización en América Latina: de la "Caja Negra" al "Casillero Vacío"*, Cuaderno 60, CEPAL

productive linkages or relations with the local academic institutions, a part from the necessary modernization of curriculums in training centers for human resources. In any case, the establishment of these industries is not a very relevant topic for economies abundant with natural resources, on the contrary, this seems to be as was the case with import substitution, the quest for an engine of development independent from the continent's natural resource endowment.

To sum up, there exist three main lines of economic reasoning that could support the idea that the abundance of natural resources is an obstacle more than an advantage in the process of development. The three lines reach policy recommendations that would de facto mean that it would be better to do nothing with the natural resources of the region, or at the very least do not shed any new light on the issue of what to do to best make use of the natural resources.

The first line of argument points at the inconvenience for a country to specialize in export products that have a relatively inelastic external demand. The argument does not go so far as to explore the process through which one type of specialization could lead to a new and better export profile. The central policy recommendation trusts that the intervention in the structure of relative profitability by itself should be enough to induce the substitution of one type of specialization by the other. It does not analyze the question of how industries evolve towards more sophisticated products with higher demand elasticities.

The second line of argument points at the multiplier effect and the force by which certain investments induce other, related investments. The big projects in exploration and processing of natural resources would not have inducement effects as strong as big manufacturing investments do. To oversimplify matters, one could say that its policy implication would be to procure complete and integrated production chains and therefore would have to privilege investments in activities that complement those chains, leaving to a secondary priority considerations of efficiency in resource allocation. It does not analyze how industries evolve to incorporate different links in the production chain.

The third line of argument bases itself on the existence of dynamic externalities, more precisely the speed of learning. These externalities are supposedly bigger in economies specializing in high-technology sectors. This last argument usually assumes, without much empirical evidence, that technology requirements are more demanding in manufacturing industry than in natural resource processing industries. It supposes that productivity increases in natural resource exploitation would not have a great impact on productivity in other economic activities.

### 3. The solution lies in the cluster

Which factors determine that an industry evolves to differentiated products with a higher demand elasticity? Which factors determine that an industry incorporates new links in its production chain? What is the room for technological innovations and productivity increases in natural resource-based sectors? How does the learning process in natural-resource based sectors affect the efficiency of other sectors of activity?

In the 1990s a literature has been developed that apparently aims to answer the questions above. The Anglo-Saxon literature on clusters strives to explain precisely the determinants of these evolutionary processes. The four issues in the above-mentioned questions, for example, are the same as the four patterns of upgrading in an industry. Humphrey and Schmitz<sup>6</sup> give them the following names:

- Process improvement: firms may improve processes –transform inputs in products in a more efficient manner—through reorganization of the production system and the introduction of new technologies. This is related to the question what is the room for innovations and productivity increases in natural resource exploitation.
- Product improvement: firms may improve products by moving to more sophisticated product lines (i.e. those that have higher unit values). This is related to the question how industries evolve toward differentiated products with a higher demand elasticity

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<sup>6</sup> Humphrey, J. y H. Schmitz (2000), "Governance and Upgrading: Linking Industrial Cluster and Global Value Chain Research", Working Paper 120, Institute for Development Studies, Brighton, UK

- Functional improvement: firms may absorb new functions in the production chain such as design or marketing. This is related to the question how industries evolve toward the absorption of new links in production chains
- Intersectorial improvement: firms may apply competencies acquired in a particular production chain to other sectors of production. This relates to the question of how important the learning process in natural resources may be for productivity in other areas of economic activity.

The term improvement suggests that there are processes, products, functions and sectors that are “better” and others that are “worse”. This notion is present in the distinction that Porter<sup>7</sup> makes between inferior and superior competitive advantages. There are different ways to compete, some better than others in the sense that some contribute more than others to sustainable development. Fajnzylber (1990) named the former “authentic competitiveness” and the latter “spurious competitiveness”. The “inferior” advantage or the “spurious competitiveness” bases itself typically on lower costs of production. This type of competitiveness is characterized by the incessant search for cost reductions and efficiency gains in existing processes and products as a first priority. Of all forms of improvement, process improvement is the most relevant in “inferior” competitive advantage strategies. The superior competitive advantage or the authentic competitiveness typically is characterized by the search for differentiation and the priority attached to quality over cost.

The capacity to improve, be it in processes, products, functions or sectors is practically synonymous to the capacity to innovate in the Schumpeterian sense of the word. What determines the capacity to improve or innovate? In the original analysis of Schumpeter, technical change (inventions) depend on the animal spirits of talented entrepreneurs. In his later work, Schumpeter started to endogenize the explanation of technical change into his theory, by recognizing the importance of the process of research and development in big firms. The occurrence of innovations is thus explained by the research and development effort of firms, determined by the capacity to appropriate the benefits of that investment, related to the capacity to affect the process of price formation. It is an analysis that privileges the determinants of supply of technology.

Half a century later, Porter introduces forcefully the determinants of demand of technology. He distinguishes five competitive forces that may explain the innovation process, which may be grouped in two groups: pressure (existing competitors, potential entrants and substitute products) and power (of negotiation, with consumers and suppliers). To simplify, the argument may be presented in the following way. A firm innovates if put under pressure and if it lacks power to protect it from pressure. If the firm does not innovate, it succumbs. The types of innovation are also two: reduce costs or differentiate. The option depends on the strategic vision of the firm. In the long run, differentiation delivers a more durable competitiveness than the cost reduction strategy.

This way, Porter basically explains how market pressure and consumer demand generates learning at the firm level. He does not explain, however, how in a certain economy the technological capabilities are created for firms that adopt a differentiation strategy. He takes as given the existing capacities and argue that firms will interact with those capabilities to build competitive advantage.

The neoschumpeterian or evolutionary school of thought has progressed in the synthesis of supply and demand forces that explain the innovation process. Lundvall<sup>8</sup> concludes that the performance of individuals, firms, regions and countries depend directly on the capacity to learn and adapt to the changing conditions of technology and markets. In the new “learning economy” the determinants of success are the degree of exposure to change and the capabilities to acquire information and knowledge to build new competencies, or in other words, to assimilate change, learn, adapt and finally produce new changes or innovations. The policy recommendation is essentially to increase the exposure to change and improve the capacity, above all of the weakest in society, to cope with change. In his model to explain the capacity to

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<sup>7</sup> Porter, M. (1990), *The Competitive Advantage of Nations*, New York, The Free Press

<sup>8</sup> Lundvall and Borras (1997) *The Globalising Learning Economy: Implications for innovation policy*, TSER report for the Commission of the European Union

learn, Lundvall points out two elements (degree of exposure and capability to cope) that are essentially the same as the forces that Porter identifies (pressure and power).

Lundvall and Borrás observe, as does Porter, that success doesn't come in an isolated manner in certain individuals or firms. This is so because knowledge is still difficult to trade. Codified information and knowledge may be traded easily across the globe, but tacit knowledge (know-how) is not. Crucial elements of knowledge are still specific and tacit, imbedded in organizations, persons and regions. This is the main reason why international specialization patterns are sticky and productivity gaps persist among regions and countries.

The observation of the importance of geographical proximity has a long standing tradition in economics. Marshall already in 1890 introduced the concept of agglomeration externalities, that are economies that accrue to a firm because of its proximity to others. The typical case is the availability of a pool of specialized human resources, reducing the cost of searching and hiring specialized personnel. In the same vein, the availability of commercial information and specialized technology is a clear example of positive externalities. Marshall also coined the term of industrial districts for those places where externalities of agglomeration are particularly intense.

In the neoschumpeterian tradition, the importance of geographical proximity is not analyzed only in terms of the existence of certain public or club goods such as human resources or information, or in the strength of the multiplier effects or the reduction of transaction costs; it is also analysed in terms of the importance of proximity for learning and the capacity to adapt and cope.

Learning through interaction among firms is important mostly because it increases the diffusion of specific and tacit knowledge. This occurs spontaneously (through imitation) or in an organized fashion, through the creation of collective institutions for training, research and development or information gathering. Both forms are expressions of so-called Regional Innovation Systems, a concept with which the cluster approach bears considerable affinity<sup>9</sup>.

Another step is to recognize the potential benefit of collective action to resolve common problems or to create more collective efficiency. To Schmitz<sup>10</sup>, the externality approach is insufficient because it aims at secondary or non-intentional effects of geographic proximity. The collective efficiency approach allows the understanding of intended efforts as good for development. This contrasts with the basic tenet of neoclassical economics that interprets cooperation among firms as something that hinders the working of markets through collusion and therefore is bad for development.

In sum, improvement or innovation in processes, products, functions and sectors depends on geographic proximity because this increases pressure from competitors and consumers and improves the capability to cope with pressure. The latter has static and dynamic components that stimulate tacit knowledge and learning through interaction. If we wish to advance from mining into fostering differentiated products, absorption of new links in production chains and the generation of new activities, we have to understand the workings of the interaction among agents in mining clusters in Latin America.

#### 4. The strength of a fuzzy concept

What are clusters, agglomerations, districts? What is the object of study? At first, the project at hand focused mainly on acquisitions of inputs and intermediate goods by big mining firms. The implicit idea was to search for goods bought elsewhere that could be produced locally. The case studies on the Southern Peru Mining Corporation and the Yanacocha gold mine in Peru, as well as the study of bauxite mining and aluminium production in the State of Pará in Brazil, started out this way. The study on buyer-supplier relations in the Antofagasta region did not focus as much on what could be bought locally but on the question what is wrong in the relation between big mining firms and local suppliers.

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<sup>9</sup> De la Mothe and Gilles (1998) *Local and Regional Systems of Innovation*, Kluwer Publishers, Boston

<sup>10</sup> Schmitz (1997) "Collective efficiency and increasing returns". Brighton: Institute of Development Studies.

The marked emphasis on the physical transformation of the minerals and its empirical application with the help of input-output matrixes to visualize links in the production chain susceptible of local production, was gradually abandoned. In its place, more attention was given to support services and intangible aspects of sustainable competitiveness such as the process of generation of local capabilities of learning and innovation. The scope of the project also changed from the national level strategies to regional and local policies to strengthen competitiveness. Finally, the focus of research changed from the analysis of one major buyer to the analysis of relations between firms, among small ones, and the institutions related to mining.

The cluster concept used in the project implied a geographic concentration of firms and institutions related to mining, in which an endogenous process of upgrading competitive advantages was observable. At the international seminar in November 2000, a main point of discussion was to what extent mining clusters did exist in Latin America, mainly because the participants questioned the supposed presence of the endogenous innovation capability. In Latin America without doubt places do exist where mining is the main economic activity, but without a clear evidence of the dynamics of innovation. In most cases, these places could simply be classified as agglomerations related to mining, in which at most certain economies of agglomeration are observable. The main question was why these agglomerations lack the capability to innovate.

All this makes the object of study rather fuzzy. The cluster literature also comprises a rather heterogeneous group of study objects. The levels of analysis vary from small groups of firms to main sectors in an economy. This project aimed at an intermediate, sectorial or meso level of analysis, following the classification proposed by Roelandt and Den Hertog<sup>11</sup> (1997)

Table 1. Levels of Analysis and Cluster Concepts

Level of Analysis	Cluster Concepts	Study Objects	Examples
National or macro	Sector linkages in the structure of an economy	International trade specialization patterns	Mining and its linkages with other sectors in an economy
Sector or meso	Inter- and intra-industry linkages	Strategic Competitive Advantage	Copper mining in the Antofagasta region and local goods and services
Firm or micro	Firm contacts	Business plans, associations and strategic alliances	A group of firms that makes a joint effort to foster a minerals port

Source: adapted from Roelandt and Den Hertog.

At the highest level of aggregation the cluster concept is used to identify the broad areas of specialization in an economic structure and the relations with other sectors in the economy is analyzed. The Monitor Group, one of the consulting firms most active with national competitiveness strategies in Latin America, calls it the “fingerprint” of an economy and distinguishes for example sectors such as “leisure industries”, “food” and “professional services”. Drejer et.al<sup>12</sup>. talks in this sense of resource areas. On the other end of the spectrum, at the microeconomic level the cluster concept is used to identify small groups of firms that are willing to take collective initiatives to produce direct and tangible benefits to each one of the participants. The ECLAC/IDRC mining cluster project is oriented at the intermediate level between the small groups formally organized to obtain a specific goal and the analysis of macrosectors in an economy. This intermediate level is a geographic concentration of dozens or hundreds of specialized firms that exhibit a strategic position in the market and to a certain extent a collective advantage in technology, information and knowledge.

The concept thus crosses the boundaries of traditional definitions. It does not necessarily coincide with trade classifications or national accounts aggregates; it does not necessarily follow the boundaries of local

<sup>11</sup> Roelandt, T.J.A. and P. den Hertog (1999), “Cluster Analysis and Cluster-based Policy Making in OECD Countries: Introduction to the theme”, in: OECD: Boosting Innovation: the Cluster Approach, OECD Proceedings, Paris

<sup>12</sup> Drejer, I., F. Kristensen y K. Laursen (1997), Studies of Clusters as a basis for industrial and technology policy in the Danish Economy”, paper presented in OECD workshop on “Cluster Analysis and Cluster-based Policies”, Amsterdam, 10-11 October

or regional public administrations. Nor do academic institutions, private sector organizations or non-governmental organizations cover exactly the group of firms and institutions that conform a cluster. Even more so, the agents that conform a cluster are a volatile group. Therefore the parallel suggested by the cluster concept with the chemical science is so attractive. In chemistry, a cluster is a temporary constellation of atoms that convey certain particular characteristics to metal compounds.

The geographic concentration refers to firms and institutions, not necessarily to production processes or markets, that may refer to different geographical spheres. Jacobs and De Man<sup>13</sup> offer a typology of clusters in which the geographical sphere of the market is used together with the geographic variable of production processes. Table 2 illustrates this with the help of examples taken from the Netherlands.

The geographical scope of the production network distinguishes between clusters that have linkages to global, regional or local production networks. The international transport cluster in the Netherlands would be, in this case, a geographical concentration of specialized firms that has a global service and production network and is oriented to a global market. On the opposite extreme, the cluster of fresh flowers is supported by a local production network and orients itself to a global market.

Table 2 overcomes the idea that clusters have by definition completely integrated local production networks ranging from the production of raw material to the delivery of the end product. In some clusters there are production linkages with remote production areas. These links may refer to the provision of raw material and parts of the production process, or to the consumers and marketing chains. In the case of mining clusters in Latin America, markets are usually outside the region.

The cluster concept is therefore a fuzzy one<sup>14</sup>, without commonly accepted operational definitions. The case study research in this project was therefore done with not necessarily identical frameworks, focussing on different dimensions of the cluster process.

Table 2: The geographical dimensions of production and marketing

Production network	Market dimension		
	Global	Regional	Local
Global	International transport	Bicycles	Cable TV
Regional		Trucks	
National	Milk machinery, yachts		Yachts (inferior segment)
Local	Flowers, Greenhouse construction	Tomatoes, Fotocopy machines	Construction

Source: Jacobs and De Man

The strength of this concept lies in its flexibility to accommodate to the heterogeneous specificity of each case. It adapts well to different geographic size, to groups of firms with variable conformations and specific institutional settings. It also serves its purpose very well in action-oriented research. In the end, each cluster case study asks the same central question regarding the strategy of improvement of competitive advantage in a group of agents with common interests. Probably because of these strengths the concept has drawn world-wide attention and has proven its suitability to mobilize collective effort in different settings.

##### 5. The cluster approach in each case study and the central issues in the mining cluster project.

The definition of the object of research and the emphasis in each case study underwent changes as the project advanced. This in itself reflects a learning process. One of the first studies in the project is the work by Katz, Cáceres and Cárdenas<sup>15</sup> on technology strategy in Chilean mining firms. The specific question in the paper is how macroeconomic, mesoeconomic and microeconomic variables shape firm strategies and

<sup>13</sup> Jacobs, D. and A. de Man (1997), Clusters, industrial policy and firm strategy, paper presented at the OECD workshop on Cluster Analysis and Cluster-based policies, Amsterdam, October

<sup>14</sup> Markusen, A (1999), "Fuzzy Concepts, Scanty Evidence, Policy Distance: The Case for Rigor and Policy Relevance in Critical Regional Studies", Regional Studies vol. 33.9

<sup>15</sup> Katz, J., J. Cáceres and K. Cárdenas (2001), Dimensiones Macro y Meso-económicas en la Evolución de la Minería en Chile, in Buitelaar, R. Aglomeraciones Mineras y Desarrollo Local en América Latina, CEPAL/IDRC/Alfaomega, Bogotá

how these variables interact among each other. The research used Chile as the geographical space and works with four representative agents taken from real firms. This paper does not focus on geographical proximity and economies of agglomeration as a study object, but its conclusions are very relevant for the project on mining clusters.

Two other papers that started early refer to the case studies in Peru, in which the original question was to which extent big mining firms, in particular Yanacocha<sup>16</sup> and Southern Peru Copper Co.<sup>17</sup> use local suppliers of goods. Both papers also performed an analysis of the production chain at the national level, and therefore a separate chapter was included in the book with a nation-wide vision on the evolution of mining industry in Peru and its impact on development. In the course of the project these studies focussed more on the local geographical dimension and to the relation with local (as opposed to national) suppliers and institutions. Although both case studies illustrate how big mining firms relate to their local environment, in particular Kuramoto was less satisfied with the quality of these relations in terms of learning through interaction. Later in the project she was able to include another case study on a medium-scale mining project involving national capital. The case of Tamboraque<sup>18</sup> shows the potential of interaction among firms and local institutions and the possibility of collective learning.

Also the work of Chami on bauxite mining in the Northeast of Brazil<sup>19</sup> started with the idea to explore which links in the production chain could be added to the existing three firms of a Brazilian holding involved in aluminium production. In the course of the investigation the possibility was discarded of absorbing locally other links in the chain. The orientation of the research changed to the relation between these big investments and the local economic development. The paper highlights one of the most interesting possibilities of learning and applications thereof to other sectors, in particular regarding environmental management of the Amazon rainforest.

A paper was prepared on a case outside Latin America to have a comparison with a virtuous and developed mining cluster. The paper on Canada by Ritter<sup>20</sup> intends to show a general vision of the economic activities related to mining in that country and how the competitive advantages shifted over time. To bring the local dimension more into focus a section on the development of the mining cluster around Sudbury was included.

At the end of the project two studies were carried out in places where mining is clearly the main economic activity. These papers ask the question how competitive advantage and learning through interaction takes place in such a setting. One of the papers refers to Oruro in Bolivia<sup>21</sup> and tells the story of a place that witnessed the boom and decline of tin mining and how it recomposed itself around polymetallic mines. The other<sup>22</sup> refers to Remedios, in Colombia, where one big gold mine cohabits a small area with a large group of informal small gold miners.

Furthermore, the project made good use of the circumstance that Culverwell had spent two years in Antofagasta, in Chile to do interviews for her Ph.D. on the relation between big mines and local suppliers. She contributes with a paper focussing on that supplier management<sup>23</sup>. The two papers on Chile are complemented with a paper<sup>24</sup> on perhaps the most essential question in the project: How do innovations diffuse in a mining cluster? More specifically, the question of the research was how a particular technological innovation, namely the introduction of thin-layer leaching, in particular its bacterial version, was brought about and was diffused throughout the copper mining cluster in Chile.

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<sup>16</sup> Kuramoto, J. (2001), La aglomeración en torno a la minera Yanacocha S.A., in Buitelaar (op.cit)

<sup>17</sup> Torres-Zorrilla, J. (2001) El complejo de cobre de la Southern Peru, in Buitelaar (op.cit.)

<sup>18</sup> Kuramoto, J. (2001), El caso de Tamboraque, in Buitelaar, (op.cit)

<sup>19</sup> Chami Batista, J. (2001), ¿Es posible un cluster en torno al bauxita en el Estado de Pará?, in Buitelaar (op.cit.)

<sup>20</sup> Ritter, A. (2001), La aglomeración en torno a la minería en Canada: estructura, evolución y funcionamiento, in Buitelaar (op.cit.)

<sup>21</sup> Loayza, F. and I. Franco (2001), Dinámica de la aglomeración minera en Oruro en un contexto de crisis, in Buitelaar (op.cit.)

<sup>22</sup> Cock, E. and W. López (2001), Conflicto y colaboración en la minería de oro en Segovia y Remedios, in Buitelaar (op.cit.)

<sup>23</sup> Culverwell, M. (2001), Desarrollo de proveedores en la región de Antofagasta, in Buitelaar (op.cit)

<sup>24</sup> Beckel, J. (2001), Una innovación tecnológica en la minería cuprífera en Chile, in Buitelaar (op.cit.)

Finally, the papers prepared in the project should serve to answer the following questions:

What are the competitive advantages of mining clusters in Latin America, how have they evolved over time and what determined that evolution?

What has been the role for public policy in the performance of the mining clusters?

What strategies and collective actions, public and private, could stimulate the potential for upgrading of competitive advantage in mining clusters in Latin America?

These questions are addressed in the next section.

## II. A synthesis: Potential and limitations of mining clusters in Latin America

### 1. The questions.

Mining is important to Latin American economies. The region stands out because of the abundance of its mineral resources. Nevertheless, the exploitation of this wealth has not brought about a satisfactory development path. For over 50 years economists have argued that the problem resides precisely in the trade specialization pattern of the region, geared to exports of natural resources. Primary products do not have a dynamic external demand in world markets and the multiplier effect of mining investments appear to be limited. The exploitation of natural resources appear not to produce economy-wide productivity increases as fast as investments in other activities do, because mining would be less intensive in the use of knowledge and technology.

The ECLAC/IDRC project assumes, as do most analysts on this issue, that there is nothing inevitable about this eventual causal relation between initial endowment of natural resources and the unsatisfactory performance of economies. The problem lies not so much in the starting point itself but in the evolutionary dynamics. Several of today's most advanced economies have an abundant natural resource endowment and were at one point in time exporters of minerals. It is true that primary products have not been a dynamic part of world trade, but the question remains as to why Latin America did not evolve toward exporting more dynamic products. Traditionally, mining has had characteristics of an enclave, but the answer as to why domestic linkages did not develop is unclear. There is even less evidence on the supposed lesser knowledge and technology intensity of mining and its supposed lesser impact on economy-wide productivity increases, so the question is open as to what the importance is of research and technological development in mining. What is the scope for innovation and productivity increases? How does mining produce learning and how does that affect productivity in other sectors of the economy?

The supposed causal relationship between natural resource abundance and economic performance involves necessarily other variables in the nature of economic policies. This project explored the interaction among agents involved in mining in specific locations as a variable that determines the dynamics of development. The literature on competitive advantage and clusters suggest that in places where there is a critical mass of specialized firms, a process of upgrading competitive advantage arises because of learning through interaction among firms, specialized institutions and demanding consumers. This process may take different paths: a change of product mix or differentiation of products to aim at higher market segments; absorption of different links in the production chain to add value to local production; innovations to improve efficiency and productivity; and also shifts to other economic activities that have a better potential for development.

If in Latin America mineral exploitation has not produced a satisfactory level of development like it has in some of today's most developed countries, the question should be what has inhibited the upgrading of competitive advantage in the region's mining clusters. What can be done about it? The ECLAC/IDRC project asked a dozen of researchers to identify a mining cluster or a relevant research topic to elaborate on this discussion and provide answers to these questions.

At the start of the volume the central questions were put forward. What are the competitive advantages of mining clusters in Latin America and how have these been built; what is the potential for collective action and public policies to stimulate upgrading to enhance the perspective of sustainable development?

The researchers collaborated with the project from different conceptual viewpoints and shed lights on different dimensions of the issue. In first place, this last section offers a synthesis of the case studies. Second, it extracts main answers to the questions put forward. Finally, the section closes with general orientations regarding upgrading of competitive advantage in mining clusters and its contribution to sustainable development in the region and puts forward an agenda for future research.

## 2. The explorations

### a. The example of Canada.

Ritter provides the example of a country with abundant mineral resources, that succeeded in the time span of a century to achieve a high level of development. In Canada, furthermore, mining continues to be a central economic activity. The country exports primary products, but the export profile is nowadays quite diversified and contains products that have high demand elasticity and high technological content.

One of the highlights of the recent Canadian experience is the globalization of the firms related to mining, a phenomenon that according to cluster literature is the most advanced stage of development of a cluster. Supported by a financial system capable and willing to invest in exploration and due to the accumulation of geological knowledge and information, the central firms exploit mineral resources in the whole world. That has a positive impact on suppliers of equipment, instruments and machinery, in particular those used in exploration. Not all links in the production chain have been developed in Canada, and the weakness in some areas particularly of machinery for surface mining worries the author.

The description of the mining cluster in Canada includes a large and diversified number of specialized agents, including mining firms and its suppliers, consultants and other professional services, financial institutions, universities, private sector associations and specialized press. Different public agencies fostered initiatives to provide the cluster with basic infrastructure and information, a common strategic vision and large, indivisible public investments. The interaction among all agents has produced knowledge and specific capabilities that give Canadian firms an edge in global competition.

Ritter also offers the example of the particular case of Sudbury, mining town by excellence, where firms and local institutions were able to solve old environmental problems and build a more attractive place to live. Now it is the center of some first rate mining technology institutions and world class firms.

### b. Aspects of Chilean mining

After reviewing the Canadian experience, the project offers three visions on mining in Chile. Katz, Cáceres and Cárdenas describe the process of accelerated growth in Chilean mining over the past decade and a half, in which a stable macroeconomic environment, the guarantees to foreign direct investment and the quality of mineral deposits stimulated huge foreign investments to open new mines and exploit more fully existing ones. The magnitude of growth also allowed the upsurge of specialized local suppliers of goods and services, strengthened human resource formation and brought about positive changes in local mining culture. In short, the recent Chilean experience shows a noticeable progress toward a cluster with virtuous interactions among agents and a significant learning process at the national level.

The problem explored by the authors is that macroeconomic signals do not affect private agents in a homogeneous fashion and that the special characteristics of each mineral deposit lead to divergent firm strategies. Codelco, the state firm, operates under an incentive structure quite different from transnational corporations such as Escondida. Another difference is the age and quality of the mineral deposits. Codelco only recently is embarking on a policy of external strategic alliances but Escondida does not have a major incentive to support an important local technological effort. Small firms served by ENAMI do not show signs to change their survival strategy because neither the macroeconomic stimuli nor the improved national technological capabilities affect them in a significant way. The Chilean mining cluster is therefore not a coherent cluster of firms with a shared strategic vision. The result is that collective technological effort is less than what would be needed in order for the cluster to upgrade from the standard competitive

advantage of a quality deposit and a favorable business climate to a more advanced form of competitive advantage based on local innovation capabilities.

Beckel analyzes the most conspicuous example of how, in this time of increased investment, a certain process of endogenous technological innovation took place in the process of copper production. The development of thin-layer leaching and in particular the use of bacteria to improve the process was, to a fair extent, the fruit of an effort realized by the Pudahuel Mining Society, although it benefited also the capabilities of other firms and institutions operating in Chile and abroad. Some major firms, among which Codelco, also adopted own research in the same direction but efforts were not articulated adequately. This observation confirms the hypothesis of Katz et. al. of diverging technology strategies. In any case, the technological innovations in the copper mineral processing and the diffusion thereof, mainly at the national level, strengthened the competitiveness of the better part of mining firms in Chile. Also high-level mining consultancy services were exported regarding the application of the new technology. The study identifies also the obstacles to a faster diffusion of the new technology in Chile and abroad and why the process was not used more widely. The end to the story is a bit disappointing as there exist serious doubts about the future of research and technological development efforts in the mentioned hydrometallurgical field.

The heterogeneity of the mining cluster in Chile is at the forefront of analysis in Culverwell's article on the obstacles to the integration of local suppliers in the production chain in the Antofagasta region in the North of Chile. She suggests the existence of two distinct and parallel clusters, one including modern, sizeable and technologically advanced suppliers and the other with marginal, smaller and technologically backward suppliers. The first offer products and services of strategic importance to the buyer firms and fit well into the strategic aims of the latter. Most supplier firms, however, do not supply products or services that are essential to the competitiveness of big mining firms and do not have the slightest power of negotiation. In these cases, big buyers look for the highest possible cost reduction and thus eliminate the possibility of accumulation in small local suppliers. This group of suppliers is vulnerable and relations of trust and collaboration are difficult to achieve. Under these circumstances, Culverwell analyzes three examples of initiatives that try to better articulate the cluster. Her conclusion is that the cluster will only achieve greater coherence and collective efficiency if the big mining firms become convinced that local development in itself is a strategic objective for long-run competitiveness.

### c. Peruvian Projects

Peru is another mineral rich country with an important mining history. To put into perspective the three case studies oriented to the analysis of local links of three firms or projects, Kuramoto offers an overview of the evolution of mining clusters in Peru. External shocks and changes in economic policy have led to different phases in the development of mining clusters, with alternating predominance of national private capital in projects of different sizes, foreign capital in large size operations and state participation. The dynamism of big national firms and groups has depended mainly on international prices of commodities, implying a considerable degree of vulnerability. At some point in time, important linkages with local suppliers of inputs and services were developed. In the last two decades this group of firms has been under pressure and the growth of mining industry has been centered around big foreign investments. These are more closely linked to foreign suppliers and the linkages with the domestic economy have declined. Taken together, the mining cluster in Peru show different forms of interaction, with certain agglomeration economies mainly concentrated in Lima and the central mountain range, and to a lesser extent around the transnational firms with a longer history in the country.

Hereafter, Kuramoto offers an in-depth analysis of the local relations of the Yanacocha gold mine. The project itself contains an interesting example of a strategic alliance between a transnational firm and the strongest local mining group. The case also is relevant because it represents the introduction of modern mining to the country, with advanced technology and a firm culture new to the country. As a conglomerate of foreign and national interests, the project shows clear synergies. Nevertheless, its relation to the local economy in Cajamarca is ambiguous. The mine has brought commercial activity and an improvement in basic services, but the limited industrial activity in the region has hindered the development of local suppliers of any significance. There are indeed local service providers, but mainly of a low technological

content. Even so, there is evidence of problems that arise from cultural differences, not only with local suppliers of services but also with local academic institutions dedicated to human resource formation.

If there is at all learning through interaction and dynamic economies of agglomeration, these are more apparent in the wider industrial network and are concentrated mainly in Lima. Therefore, Kuramoto speaks of an industrial network around Yanacocha, expression in which the term network contrasts with cluster in that it does not imply the geographic proximity as a component that produces interaction. In any case, the relation between this network and the local mining cluster of small and medium mining firms is virtually nonexistent.

A project that has a history of more than four decades is that of the Southern Peru Copper Corporation that exploits the copper mines of Toquepala, Cuajone and others in the south of Peru. Torres did a detailed analysis of local procurement of goods as well as other relations of the firm with the local economy that have been established over time. The production complex does have important backward and some forward linkages. Its impact on the local economy in the southern part of Peru is no doubt very important. The sheer size of SPMC in comparison to the local economy is large. Locally procured inputs remain, nevertheless, of the low-technology type. A different situation occurs with local services procurement, where some cases of higher technology services are registered. The progress is noticeable above all in the phase of implementation of new projects, in which an increasing percentage is won by local constructors. The mining cluster in the south of Peru also shows some interesting links with the North of Chile.

Tamboraque is the third case study in Peru. Kuramoto identified the case because of the characteristics that set it apart from the other two Peruvian cases. It is a medium-sized mining project, owned by national capital, made possible because of a direct cooperation between half a dozen key local actors.. It reflects the potential of interaction among foreign firms (an investment fund, engineering firms) and local agents (the investor, a training center and an equipment producer) to establish jointly an endogenous capacity to carry out a medium-sized project. It is therefore, in this collection of case studies, perhaps the clearest and most virtuous example of deliberate collaboration among firms and institutions that has produced clear synergies, technology transfer and local learning. The analysis of how it works and why shows the variety of actions undertaken on the part of public institutions and international organizations. Nevertheless, it was the initiative and leadership of a local entrepreneur and the support of a private vocational training center (in itself an expression of collective action of local private mining firms) that has taken the multiple impulses to a concrete result.

#### d. Other cases

The ECLAC/IDRC project analyzed cases in three other countries: Brasil, Bolivia and Colombia. In Brazil, Chami started his exploration with the question what other links in the production chain could be incorporated in the already existing chain of three firms pertaining to the Aluvale conglomerate in Pará. One firm extracts bauxite, another transforms it into alumina and the third produces aluminium. Chami analyzed the forward and backward linkages in the production chain and reached the conclusion that, although there are numerous linkages in a typical aluminium production chain, there are no economic and technological arguments that justify the incorporation of these links in the existing production structure in Pará. The competitiveness of each forward or backward link does not depend critically on geographic proximity of bauxite extraction, alumina or aluminium production. It is also not the case that learning in each link affects learning and productivity in the other links. Critical information and knowledge is not transmitted along the chain. To bauxite extraction, critical knowledge is of a geological nature; the transformation into alumina is a metallurgical process. The production of aluminium requires electrochemical knowledge and information. The backward linkages to equipment manufacturing may benefit from agglomeration economies with other metalmeccanic sectors. The forward linkages are extremely diverse, as are the uses of aluminium, and for the most part require technical and economic conditions that do not depend on the proximity to the bauxite-aluminium complex.

Having arrived at that conclusion, so negative for the expectations to complete the physical production chain in Pará, Chami dedicated himself to the study of the relation between the conglomerate Aluvale and the local economy in more general terms, to find out what other positive agglomeration effects there could

be and what forms of interaction and learning may be encountered. This part of the paper is unique in this project in that it shows clearly the potential for intersectorial learning. Basically, the most important learning aspect after twenty years of bauxite extraction refers to the reforestation of the Amazon rainforest. The most important legacy the conglomerate may leave to the local economy is the knowledge and capacity to manage the tropical rainforest. This is an important advantage of agglomeration that may be enhanced through concerted collective action between public organizations and local academic institutions as well as firms and NGO's.

The study on Oruro by Loayza and Franco is also unique in this collection, in the sense that it shows the collapse of a mining cluster around tin and its recomposition around polymetallic mining. In this last phase, a clearly bipolar structure was arrived at with a small group of modern firms and on the other end a dozen cooperative enterprises. The first group is composed of big national firms that succeeded in establishing joint ventures with transnational firms and thus were able to assimilate technological change. The second group is the result of the response of workers affected by the tin crisis. On its turn, a small group of supplier firms and institutions pertaining to the previous period, succeeded to adapt to the changing environment with an aggressive strategy to diversify. In all, the mining cluster in Oruro depends essentially on the dynamics of large multinational corporations, that on its turn depend on external variables. The public sector, the universities and local private sector organizations do perform important functions but do not appear to have enough critical mass to impose an endogenous dynamics of upgrading of competitive advantage.

Finally, a case study was included regarding a minicluster of gold mining in the municipality of Segovia-Remedios in Colombia. It is a singular case also in the sense that it concerns a small area fully dependent on gold mining, in which a big modern firm, co-managed by workers with a clear local and social awareness, coexists with about a hundred small scale, mostly informal miners. The close proximity and even conflicting claims on the land force some kind of collaboration, that indeed could bring significant agglomeration economies and social and environmental benefits. However, collaboration has been difficult to agree upon, probably because of the irregular situation of most miners regarding their property titles. The bottom line is that there are probably diseconomies of agglomeration. The interesting feature of the work on Segovia-Remedios is that it reports the most practical proposal to local collaboration in the present collection, made by the big firm.

### 3. The answers.

What competitive advantages exhibit the mining clusters in Latin America? The case studies in the ECLAC/IDRC project reveal the high degree of heterogeneity in Latin American mining, both within clusters and between clusters. On the one hand, the copper mining cluster in Chile, be it considered as a national cluster or as a local cluster in the North of Chile where the biggest concentration of mining activity is, has been clearly impulsed by big investments in exploration and exploitation by foreign firms and Codelco. There also have been important investments in support infrastructure (energy, ports and specialized transport systems for minerals). It is obvious that these investments were attracted by the abundance of mineral deposits, but the critical factor was probably the favorable investment climate. This includes a low tax rate, investor guarantees, a stable macroeconomic situation and also the strengthening of democratic institutions. In terms of Porter's stages of cluster development, this would be a typical case of competitive advantage based on investments, which is a more advanced stage than that of clusters based on sheer resource availability but less so than the stage in which innovation capacity carries the cluster. The competitive advantage characteristic of this situation is that of high efficiency in production, made possible because of the low cost of resources and economies of scale brought about by large-scale investments. The process of innovation that may be observed in that stage is that of innovations aimed to increase productivity and lower production costs.

In this sense, interesting examples of innovation do exist, such as the development of bacterial thin layer leaching, the innovation analyzed by Beckel. Even so, these very same examples show the limitations of the cluster to make full use of the innovation capacity. Thin layer leaching triggered an important improvement of production efficiency and a widening of the mineral base commercially apt for exploitation, so much so that it constitutes a paradigm change from pyrometallurgical to hydrometallurgical

technology. Nevertheless, this development was only marginally accompanied by a flow of exports of technology, knowledge or consultancy and engineering services based thereon. The local institutions do not support decidedly the internationalization of national firms that have accumulated knowledge in this area, and a number of obstacles to the export of technology-based services persist.

Together with this modern segment of transnational mining firms, big investments and interesting examples of technological innovation, a relatively large number of small local firms exist that provide basic services and inputs. This segment has the most basic and simple competitive advantage and the least conducive to sustainable development of all: the low cost of its labor force. Their negotiating power vis-à-vis the big firms is nil and their strategic importance to big firms is very low indeed. For that same reason, sometimes small local firms do offer their services on the basis of opportunity cost only. These firms are apparently in no condition to accumulate. Their importance resides in the fact that they are a source of employment for the local population in the lower segments of income.

The Peruvian case studies show in essence a similar condition to the Chilean case, surely so when the cluster is defined at the national level. The big private investments confer competitiveness to SMPC in the South and Yanacocha in the North. In these places the mentioned firms are the only ones in their category, which constitutes a difference with the North of Chile where a dozen such firms are found. But the most accomplished cluster in Peru would be found in the central mountain range, where the example of Tamboraque evidences the potential of collaboration for the transfer and local development of technology.

The differences with the Chilean case are a matter of degree, not of category. There are in Peru probably not yet as much examples of local development of new technological knowledge, as in Chile, that would allow the statement that Peru like Chile is entering the stage of an innovation-driven cluster; probably there are less big firms in the modern segment and proportionally more firms in the traditional segment that base their existence on low labor costs. The explanation is undoubtedly that the investment climate is not as attractive as in Chile because the macroeconomic and political context has been less stable.

The other case studies do not warrant comparisons on the mining cluster at the national level, only of the competitiveness of the local mining clusters around bauxite in Pará, the one in Oruro and the minicluster in Segovia-Remedios.

Without doubt, the advantage of the bauxite cluster in Pará lies also in the big investments, in production capacity and support infrastructure regarding energy and transport facilities. In this case, the investments were made by the Government and the then state firm, in collaboration with a Japanese development project. The cluster of firms around the bauxite-aluminium chain contains only a handful of firms and the agglomeration economies are therefore of marginal importance. Nevertheless, the case illustrates well the existence of spillovers to the local economy and the learning process regarding environmental management. The potential of the cluster to upgrade competitive advantage appears to lie mainly outside the central production chain, in the sphere of the application of accumulated knowledge to the management of environment.

The competitive advantage of Oruro was the availability of tin and the big investments made to exploit it; its history is interesting to observe what happens after a crisis of the magnitude like the collapse in world tin markets. The competitive advantage of the cluster today lie in the investments made to modernize technologies and reorient the local mining to a polymetallic mining that has been possible through joint ventures between local firms and some big multinational corporations. The rest of the cluster of old seeds refuge in management forms such as cooperatives that allow the reduction of costs and the operation at marginal cost price.

In Segovia-Remedios, strictly speaking, there is only one competitive firm and the competitive advantage does not lie in the interaction among agents in this so-called cluster; it is the existence of the gold deposit and the investments made by one firm to exploit it. There are local small firms whose competitive advantage comes because of their informality that allows them to avoid certain production costs that should be incorporated. The interaction among agents may start to bear some fruit only after the small firms formalize their legal existence and obtain a legal access to the resource.

#### 4. Lessons and Strategic Orientations

In general terms, mining clusters in Latin America compete in commodity markets, on the basis of efficiency in production and low costs. Mining does develop some local agglomeration economies of a static nature, mainly in the form of specialized infrastructure, but develops little dynamic agglomeration economies in terms of learning and innovation capabilities. The financial benefits of the activity accrue more in the metropolis within and outside of Latin America than in the local economies where the resource exploitation takes place. In the mining clusters, a segment of modern firms exists that has little roots in the domestic economy and pursues a strategy of efficiency. They coexist together with a segment of traditional firms that are trapped in a survival strategy. The contribution of mining to local development is therefore perceived as insufficient by the local communities. The development and improvement of local conditions are an issue of secondary importance for the efficiency of big mining firms. This situation does not allow a virtuous circle to occur that produces development.

Four strategies may be identified for mining clusters in Latin America, considering that a theoretically possible fifth strategy may be discarded off hand, namely that of product differentiation. Practically by definition, mining produces commodities that are not subject to differentiation. The first of the possible strategies is the improvement of existing competitive advantage, meaning the strengthening of local innovation capacity to increase production efficiency. The second one is the absorption in the local production chain of more value-added production that uses the metals as an input (downstream linkages); the third one is the absorption of backward linkages in the local production chain, or the production of machinery and equipment for mining operations. The fourth alternative is to strengthen the links between mining and other, apparently unrelated, economic activities. The conclusion of this project is that a combination of the first and the fourth strategy is the most likely to be successful. Local capacity to produce innovations and the use of mining's dynamism to produce competitive advantage in other sectors should be strengthened.

The big mining companies in the modern segment do have an important capacity to produce innovations, above all those to improve the efficiency of production. Nevertheless, most firms pertain to transnational conglomerates that do their innovation effort preferably in their home country. The development of a local innovation capability requires above all an impulse to the institutions of human resource training and the availability of basic geological and environmental management. It is also necessary to have a greater availability of and access to geological and environmental information, spheres in which, generally speaking, the public sector should carry most weight. Big transnational firms may contribute to the generation of that type of information only if they work from a long-run strategy in which, for example, the management of the environment is of crucial importance for their competitiveness.

The research in mining to support the competitiveness of mining firms is particularly linked to the geography of the places analyzed in this project. On this topic it has to be possible to overcome inertia and convince foreign firms to support financially local efforts of research in Latin America. Logically, this research will at first be oriented to find solutions to the problems presented by the particular geographical and geological situation in each case. The development of thin-layer leaching is an example in point. This evolution path to improve local innovation capabilities seem feasible and necessary, but probably not sufficient to fight poverty and promote economic growth and social justice in mining clusters. It is not a path in which the traditional mining segment has a clear future.

The second alternative is a long-standing proposal. The idea to promote the production of manufactured goods from the metals produced in mining clusters in the proximity of the mines themselves encounter the problem that they are distant from main centers of consumption and manufacturing know-how. The domestic markets in Latin America are in general very small indeed and basic metals are exported. Part of the problem is the tariff structure on imports in distant markets, with generally higher tariffs for more elaborated products. This issue was however left outside the scope of the case studies in the present project. The analysis was centered on the importance of the interactions within the clusters. In this regard, the distance to the final consumption centers is a clear obstacle, not only in cases where the products are exported but also in the case of the aluminium in Brazil where the primary product is transported over a

large distance to the main consumption centers in the country. The basic metals produced by the mining clusters have a wide array of intermediate and final uses, implying a logistical problem and a bigger incidence of transport costs in the case of locally produced higher value-added goods. In the North of Chile, the highest achievable stage of production seems to be the refining of the copper mineral. In Segovia-Remedios a proposal has been suggested to establish locally a gold jewelry production but the idea seems far-fetched due to the absence of a local tradition of craftsmanship, design and also the distance to and ignorance of markets. In sum, many times it does not seem to be commercially sound to build downstream linkages close to the mines. Some minor examples may be found where this has worked well, but as a proposal of strategy it does not seem wise.

Regarding the development of backward linkages, the case studies also show more limitations than potential. There are examples of mining clusters worldwide that have evolved toward the establishment of an industry of machinery, equipment and instruments in answer to specific local mining problems or to achieve more efficiency in production processes. The upsurge of these machinery clusters may be explained from the previous existence of a history of machinery production in general, as argued in the paper by Chami. Now that they exist, they exhibit their own dynamics of continuous upgrading of competitive advantage and it is difficult for latecomers to enter this type of industry. This being as it is, mining clusters in Latin America today face the trade-off between present-day efficiency based on imported capital goods and future efficiency with a local capital goods industry.

One of the important lessons of this series of case studies is the need to analyze with greater detail the fourth possible alternative, meaning the upgrading of competitive advantage by strengthening the links with other sectors. There is in Latin America a tradition to analyze only the production chain of physical transformation of minerals into end products, something that leaves out the importance of services to mining and their potential applications to other economic activities. Some services are of crucial importance to the modern segment of mining clusters and others are important for employment generation and local financial accumulation. The cooperation of big mining firms to this type of strategy is possible basically if they work from a long-run vision in which environmental management and local development are essential elements of sustainable competitiveness.

Arguably the area of highest relevance for sustainable local development derived from modern mining is the area of environmental management services. Local conditions are of crucial importance in this area and practically all cases require case-specific solutions. Local learning in those environmental services may have direct applications to other local economic activities and may become themselves internationally competitive. The examples reported in the case studies refer to environmental management of the rainforest, water management in the desert and treatment of residues. Other examples of intersectorial linkages stem from geological knowledge through mining and the opening up of remote zones that may have favorable impacts on special interest tourism for example.

While the development of forward and backward linkages in the production chain seem to encounter more limitations than potential, the development of lateral linkages through mining seem to have been insufficiently explored. Contrary to common perception in Latin America, the consequences of the strengthening of mining clusters will not translate into a more integrated physical production chain. An supplier industry of capital goods or an industry producing metal-based products will not arise in first instance. It will first reflect itself in the increase of the local component of high-value services such as engineering and other consultancy services. It is more probable that an increase in the local component of research and development produces a stronger local capacity to produce equipment and machinery than the other way around.

The diversity of mining clusters in Latin America presents, nevertheless, a serious obstacle to the strengthening of relations of collaboration and subcontracting. The existence of two or more firm models in each cluster hinders the articulation of a common strategic vision. The modern segment is related to global production chains, be they of national, transnational or even state capital. Their strategy is to reach a higher level of efficiency through cost reduction. The segment of small firms, of national and local capital, with less technological and financial capacity, adopts a strategy of survival.

The relation between both segments are problematic. The modern segments has more negotiating power and this results in a minimal profit margin and accumulation in the traditional segment. There are even reports of misuse of power and other irregularities. In this situation, relations of trust are hard to build.

To produce a path of local sustainable development on the basis of extraction of minerals in Latin America requires the consent and collaboration of all agents. Leading firms should work from a long-run strategic vision in which environmental performance and its contribution to improve local development condition are a central feature of long-run competitiveness. On their turn, local firms need to take opportunities that mining offers to develop competencies that may have applications also outside mining. Local academic institutions need to prepare human resources and research capacities to that end. It is the task of all these agents together to build a competent local authority that guarantees a constructive interaction in the framework of a common future vision.

### III An application? Toward a Mining Cluster Strategy in Antofagasta, Chile

The Regional Development Strategy 2000-2006 put forward by the Regional Government of the II Region of Antofagasta, in Chile, aims to strengthen the role of mining as an engine for development. To that end, it establishes as its fifth policy area the strategy named “Consolidate in the Antofagasta Region a mining, industrial and services production complex”. The Government Plan 2000-2003 signals a series of initiatives and projects that should be carried out to reach the goal. The plan establishes as one of its initiatives the creation of a “Management System of the Production Complex around Mining (clusters)”. The chief executive of the Regional Government, called Intendente, installed a Technical Committee to design a proposal conducive to the establishment of the Cluster Management System and has established also an Agreement of Collaboration with the Economic Commission for Latin America and the Caribbean (ECLAC) through which that international organization provides advice to the Technical Committee. This part of the paper contains the proposal made by ECLAC that is currently in discussion with the interested parties in the Antofagasta Region. The activities of the Committee have been basically to organize a broad discussion among public institutions, private sector organization, academic institutions and NGO’s to address the development strategy of the region and the role for mining in that strategy.

This part of the paper presents in first place the strategic considerations and establishes the goal of the Management System. In second place, it describes institutional and organizational aspects of the System. Finally, it proposes five lines of action.

#### 1. Strategic considerations and goals of the Cluster Management System.

*The Antofagasta Region should exploit the dynamism of the mining sector to strengthen local development*

Mining is the main economic activity of the II Region of Antofagasta in Chile, contributing close to two thirds of the region’s GDP. Mining today is a growth industry, basically thanks to the affluence of foreign direct investment, but its contribution to the local economy is perceived by the population as being unsatisfactory and the long-run perspectives of its sustainability are being questioned. At first sight, that the contribution of mining to local development should be perceived as less satisfactory, might come as a surprise because the region boasts the strongest growth figures in the Nation and per capita income is second only to the Metropolitan Area. In any case, this perception reveals a gap between reality and expectations of growth potential. Mining doubtlessly leaves economic benefits for the region but compared to the magnitude of investments these benefits are perceived to be marginal.

There is nothing intrinsic in mining that hinders it to be an engine of economic and social development in the region. This is not for everyone a self-evident statement as there is an important academic discussion on the impact of mining in local development. In the II Region of Antofagasta for a long time pessimism reigned about the potential of mining for development and the buzzword was diversification of economic activities to introduce an engine for growth independent from mining. More or less a decade ago this pessimism gave way to a moderate optimism about the possibilities to build a thriving community on the basis of mining.

The contribution of mining to the local economy may come in different forms.

- a) In first place, there are the direct employment effects and the impact of investments in local generic infrastructure. In comparison to other sectors, mining does not generate massively employment but a favorable aspect of mining is the relatively high level of wages. Also investment in generic local infrastructure is relatively limited but nonetheless important, above all in transport facilities (ports, railroads) and in the provision of basic services such as electricity, natural gas and water.
- b) In second place and very present in the local discourse because of its tangible and easy to understand nature is the possibility to supply goods and services to big mining firms. There already exists a relatively numerous group of local firms that are suppliers to mining firms. This avenue is not exempt of problems. Mining requires to be internationally competitive and therefore the demands to local suppliers in terms of costs and quality have to be the same as those the international market dictates. Local firms find themselves mainly in the low-cost segment of goods and services, they are of very small size compared to buyers and therefore negotiating power is not symmetric. Their profit margin and room to accumulate is small. The quality of jobs is low as is the wage level. The importance of this segment of firms is precisely of a social nature, in that it generates employment opportunities for the less well prepared labor force. The segment of technology-based supplier firms is still relatively small but may constitute one of the most promising ways to strengthen the impact of mining firms on local development.
- c) In third place, mining may prove a starting point for new business opportunities downstream. Today, the region produces and exports mainly copper mineral and to a lesser degree refined copper and copper cathodes. Local refinery capacity is still limited – there is one firm dedicated to that activity— and virtually nil the capacity to process refined copper for the multiple uses it may have. To refine locally more copper mineral would clearly be an activity that adds value to a primary product and would generate profits for the firms that successfully enter the business. Its weakness as a strategic option to the region lies precisely in the fact that the benefits would accrue to one or very few firms with little local ties and on the other hand could generate negative externalities in the sense of its environmental costs. Another idea, that of attracting firms to the region that would process refined copper to produce downstream intermediate and final goods has been little explored. In the same vein, non-metallic mining in the region could have an interesting potential but today occupies only a marginal place in the regional production structure.
- d) In fourth place, mining offers possibilities to strengthen other economic activities, directly or not so directly related to mining. The clearest case is that of transport and logistics. As stated above, mining has stimulated investments in local transport infrastructure, in particular ports and railroads. This constitutes a base to develop activities outside mining that use the same infrastructure, in particular regarding integration with a potential hinterland in the North of Argentina and the South of Bolivia. Another idea is the relation with tourism. Mining tourism and geological interest tourism could provide an enrichment of current tourist attractions in the region. Related to that, the idea exists to stimulate a handicrafts sector that uses copper as an input.
- e) Finally, mining and all economic activities related to it generate an indirect effect on the local economy due to the multiplier effect of investment and local expenses by mining firms. This expresses itself in the demand for local goods and services of all kinds, ranging from construction and housing, food, commerce in general, education, public services, leisure services, health and other aspects of local economic activity. The multiplier effect is still low, because an important number of people employed in mining, particularly the higher-paid, still prefer to live outside the II region. Transform Antofagasta and Calama, the second city, in attractive places to live is to a certain degree the ultimate goal of the cluster strategy. On its turn, this goal requires a set of practical initiatives set out in other parts of the above-mentioned Regional Development Strategy.

*For mining firms, sustainable development in the region is becoming a critical factor for its long-run competitiveness.*

In the perspective of modern mining firms, their contribution to local development, in economic, social and environmental terms, is critical for the sustainability in the long run of the business itself. This was not always like that. The modern attitude of mining towards its social responsibility expresses itself for example in the Global Mining Initiative and the project on Mining, Minerals and Sustainable Development

it supports. To big mining firms in the world, international public opinion regarding its social and environmental performance is an important issue. If mining is not able to demonstrate positive results with environmental management and its contribution to social development, the activity itself loses its social license to operate. If mining cannot count on a positive social valorization, it will likely encounter obstacles in the political context. Its investment projects will be questioned because of a perception of negative local impact. This will result in pressures to increase tax rates, in higher costs for environmental management, and so forth. The II Region of Antofagasta is arguably the place where mining investments are best received in the whole world and the business climate compares favorably to other places. Big mining does not wish to see this climate worsen and therefore the Antofagasta Region should be transformed in a showcase to illustrate positive effects of mining and foreign direct investment regarding local economic, social and environmental development.

*These two strategic considerations may be expressed in one: The development of the II Region of Antofagasta needs a dynamic and competitive mining sector in the same way mining firms require a prosperous region with sustainable growth.* This is the starting point for the Cluster Management System project.

Development is not an automatic result of favorable conditions and the functioning of markets. Development requires purposeful collective action and an adequate coordination of public and private initiatives. All this stems for a shared strategic vision among all agents in the region regarding how to build a better future. To build this strategic vision is the central goal of the cluster project.

The cluster concept was developed by Michael Porter to explain how in certain places a group of firms achieved global competitive excellence. The explanation puts emphasis on rivalry and collaboration among local firms. This creates new knowledge, improved technologies and synergies that express themselves in economies for firms and the locality in which they are operating. Although most of the time the cluster examples used in the literature have risen spontaneously, the role of government and collective action was frequently essential. The idea of a cluster project fostered by Government is to accelerate the process that would have come about spontaneously but slowly.

A cluster is a concentration of firms in which interaction among them and with institutions results in a collective capacity to develop innovations to cope with competitive pressure and changes in technologies and markets. Well-functioning clusters demonstrate an ability to reinvent themselves. Firms not only improve the competitiveness of their main activity, but also absorb new activities and functions. In this way, clusters exhibit an evolutionary pattern toward higher value activities. A project to stimulate the functioning of clusters aims primarily at increasing and improving the flow of information, to produce meetings between agents and to coordinate their activities.

Considering the above, it is possible and recommendable to create a Cluster Management System around mining in the II Region of Antofagasta that has as ultimate goal to stimulate local economic development from the basis of the dynamism of mining. At this level, to generate a shared strategic vision among all agents about the economic future of the region and of mining is the superior objective of the project. From this superior objective six more specific objectives are derived.

- a) To maintain and improve the competitiveness of mining industry through an improvement of the local business environment, in particular through a better coordination of regional public institutions related to mining.
- b) To improve direct links between big mining firms and local suppliers and to foster medium- and long run strategies of supplier development through the improvement of the working of local market forces.
- c) To stimulate accumulation of local knowledge from mining through the linking of mining firms with academic research and development and training institutes.
- d) To favor the local processing of minerals and the diversification of mining industry with an investment attraction program to obtain foreign and national private investment in new projects.
- e) To achieve a new social agreement between the region and big mining aimed at increasing the financing of social, educational and environmental projects by big mining firms.
- f) To foster lateral links between mining and related economic activities in the region.

To achieve each of these objectives, the activities of the Cluster Management System comprises:

- a) Providing information to stimulate the correct working of market forces
- b) Organizing meetings between people, firms and institutions of the mining cluster
- c) To create coordination institutions

## 2. The organization of the Cluster Management System

Economic activity in a social market economy and in particular the relation between mining and local economic development in the II region is a matter concerning private firms. Everything that has to do with the improvement of private sector activity and the relations among private firms need the active involvement of representatives of private firms. On the other hand, the relation between mining industry and the development of the II Region of Antofagasta concerns the whole population and therefore the Regional Government and elected local authorities are bound to have a direct role too. This conduces to the building of an institutional set-up with private and public sector participation.

Nowadays, the II Region of Antofagasta does not have an institution with such characteristics. The Regional Government is still a new institution with little financial and human resources and a great number of responsibilities. The different public institutions in the II Region have a double hierarchical relation, one toward central Government at the national level and another toward the Regional Government. Such is the case for example with CORFO, the Chilean development agency, that has a local office mainly to execute instruments designed and approved at the Central Government level. The National Fund for Regional Development constitutes the main line of funding for productive development projects in the region.

Private initiative in the region does have a series of organizations, but no one with a complete coverage and fully representative of all private firms nor with public authorities represented in its organizational structure. Thus, private sector organizations each represent a part of local business and are dedicated mostly to matters of direct interest to the constituting group.

The Corporation for Productive Development of the II Region (CDP) is the only institution that in its structure brings together representatives from private, public and academic institutions in the region and has the fostering of productive development as its goal. Today, ten private firms, two universities as well as public authorities conform the Corporation's board. In its almost ten years of activity, the Corporation has geared itself mainly to channel CORFO financial resources to small and medium-scale firms in the region.

CDP today is not the strong and representative organization that can foster the series of initiatives require to improve the mining cluster in the second region and its repercussion on local economic development. Nevertheless, there is no other organization that has the same potential. Therefore, this proposal suggests that the coordination of the Cluster Management System be situated in the CDP, as part of an effort to provide CDP with more resources and coverage.

The Cluster Management System requires a Board or Council with representatives from Regional Government, CORFO, the National Mining Company that serves small miners, the Mining Council that groups big mining firms, the Antofagasta Association of Industries that represent major local firms, the Association of Small Enterprises of Antofagasta and the Regional Science and Technology Council.

The Board should meet at least once a year to supervise the implementation of the Cluster Management System. The Board designs the Manager who works at the CDP premises as a Secretary to the Board. The Manager prepares an annual report with activities and a work program proposal.

The manager of the Cluster Management System should carry out a job aimed at stimulating and coordinating activities of different agents of the cluster, and communicate the results of those activities to decision makers and public opinion.

The Mining Cluster project is a constellation of decentralized activities. Here we do not propose a great deal of new activities, but instead a better coordination of already existing initiatives in different firms and

organizations. This proposal contains six areas of work. Each area except one requires a task force in which different agents are represented. Each task force is coordinated by a local institution different from CDP and can work in an independent but coordinated way. The task forces meet at least two times a year to establish work plans and coordinate initiatives by different institutions and specialized organizations. The one area of activities that does not require a special task force is that of multisectoral projects. Because of the nature of these projects, it is not feasible to identify beforehand a group of agents suitable to conform a Multisectoral task force. These are possibly a group of initiatives with little relation between them, such as Mining Tourism; Transport and Mining; and Water Management to name a few areas of interest. It will have to be direct responsibility of the cluster manager itself to foster these activities.

All task forces will produce information, organize meetings and create coordination mechanisms. In all cases, a number of concrete and tangible outcomes are to be achieved.

### 3. Five proposed task forces

#### a. Institutional coordination within the Public Sector.

In the II Region of Antofagasta are 52 public services, many with competencies of direct relevance for the mining industry. As the organic structure of the public sector in the region is still a hybrid one and many services depend directly from National Government, the coordination at the regional level is still very weak. This task force should coordinate activities of public sector services with direct relation to mining, in order to improve the local and regional policy environment for mining, make regulation and administrative supervision more efficient and effective, and stimulate its competitiveness. To this task force all public regional dependencies should be invited as well as representatives from mining and related industries.

Information: A survey of competencies of public services in the region relevant for mining. Coordination: A plan for coordination of public sector services relevant for the mining industry. Outcomes: A one-stop counter specialized in attending the needs of mining and related firms in terms of bureaucracy and red-tape. A compendium with regional public service facilities in support of mining.

#### b. Supplier development

In Antofagasta already exists a relatively numerous group of local supplier firms of goods and services to mining industry. There are also a series of initiatives to improve the capacity of supply of local firms to mining industry. The Antofagasta Association of Industries has established in the past few years an important project concerning evaluation and qualification of suppliers, geared at streamlining evaluation criteria for suppliers to big mining and eventually concentrate the service of supplier qualification. On its part, through the agency CODETIA it provides training courses and technical assistance to local small supplier firms.

Also CDP has a program of Production Linkages and Supplier Development, through which it channels CORFO financial resources for the upgrading of the quality of local small firms, among which are suppliers to mining industry. Another organization active in this regard is Sercotec, a CORFO subsidiary that provides technical assistance to small firms.

The development of local suppliers is an area of work that has limitations in the conditions of demand and supply. Regarding demand conditions, it is important to note that big mining firms operate in a demanding world market and require inputs and services that allow them to be competitive in terms of costs, quality and on-time delivery. The development of local suppliers cannot lead to lower requirements on these points. There is an argument that after a learning process local firms may provide perfectly competitive goods and services and that it is justifiable to subsidize this learning period. Nevertheless, also on the supply side the issue encounters limitations. Local firms usually have a smaller scale of operations than do international suppliers and also they exhibit a lower degree of specialization. This affects their potential competitiveness. In this sense, the possibility to open up extra-regional markets for these suppliers is a strategy that has until now been insufficiently explored.

The central issue here is that the relation between big mining firms and small local suppliers is not a relation in which market forces work all that satisfactorily. There are information problems in two ways between buyers and suppliers. The former do not know all the available local supply, existing or potential, and the latter do not always have all the necessary information about existing demand. It should not be forgotten that here are two very distinct firm types, with differing financial and human resources. This hinders the satisfactory resolution of conflicts that are very normal in any buyer-supplier relation. All these elements configure a situation in which mutual trust is less than that required by a long-run strategy of supplier development.

The work of the task force on supplier development should be geared toward improving the information regarding local and regional supply and demand and improve the climate of trust between both groups of firms through the creation of a mediation institution for conflict situations.

Information: Provide mining firms with information regarding local and regional supply, existing and potential, of goods and services. Provide supplier firms with information regarding requirements and demand of big mining firms. Meetings: In collaboration with existing trade fairs, the participation of local suppliers should be stimulated in those fairs. An electronic information finding system should be created for local procurement and supply. It is not a new B2B site that should be developed on top of the existing websites where local mining firms provide information regarding their procurement; it is a new site where agents may find information on where to find information. Coordination: Create an instance where discrepancies between buyers and suppliers may be analyzed and treated and mutually acceptable solutions may be proposed and reached. Outcomes: A catalogue of local supply of goods and services for mining. An electronic information point on where to find information regarding local procurement needs. The establishment of an ombudsman system for mining firms and local suppliers.

c. New businesses.

Mining in the II Region of Antofagasta still is an activity concentrated in the extraction of minerals, mainly copper. The potential to broaden the scope of economic activities in the region, both in the areas of non-metallic mining and regarding the refinery and processing of extracted minerals, is certainly there. In most cases, these are large scale projects that require a decided impulse to attract new investments, both from existing firms as from firms that should be attracted to the region, from elsewhere in Chile and also abroad.

Information: Create a portfolio of new investment projects for the region. Prepare a survey of support services for new investments, in terms of financial, technological and other support services. Meetings: Organize a meeting between project proposals, investors and support services institutions, making use of existing trade shows both within and outside the region. Coordination: Establish a mechanism of coordination between public and private investment to foster new investment projects. Outcomes: The portfolio of investment projects and the Meeting of New Mining Business.

d. Research and Training.

The essence of the success of clusters is the diffusion and generation of new knowledge and the generation of new technologies. In this sense, the interaction between firms and research and training institutions is key. In the II Region of Antofagasta there are three Universities, each with a distinct profile of specialization regarding relevant issues for mining. The relation between firms and universities is until now an informal one, building mainly on personal contacts.

One of the first results of the project to design a Cluster Management System has been the response of local universities to propose the establishment of a Center of Excellence in Mining Studies to the National Commission for Research, Science and Technology. Although the proposal has not achieved the desired result of approval and financing, the idea is the right one. The proposal has to be improved to be presented anew to CONICYT for the financing of a formal instance of collaboration between universities as well as between universities and private firms, through which the academic activities of research, human resource training and technology development may be strengthened in the region.

Information: A compendium of local scientific research capabilities, both in universities and in private firms. Products: A proposal for the establishment of a Center of Excellence in Mining Research.

e. Mining, Community, Education and Environment.

Mining should make a firm commitment to local social development and the management of environmental issues. Several mining firms in the region already are sponsoring activities in this area. These initiatives should be coordinated and strengthened. The task force on Community, Education and Environment would be the expression of a New Social Contract between mining and the region, aiming at generating more voluntary private resources from mining firms to projects of social and environmental interest. In this regard, the community has identified basic education as the main priority.

Information: A portfolio of social and environmental interest projects. Organization: a meeting between community organizations and mining firms to establish project priorities.