

# From awareness to action: Sudbury, mining and occupational disease in a time of change

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## Abstract.

**BACKGROUND:** Miners work in highly hazardous environments, but surprisingly, there are more fatalities from occupational diseases, including cancers, than from fatalities from injuries. Over the last few decades, the mining environment has become safer with fewer injuries and less exposure to the toxins that lead to occupational disease. There have been improvements in working conditions, and a reduction in the number of workers exposed, together with an overall improvement in the health of miners.

**OBJECTIVES:** This study attempted to gain a deeper understanding of the impetus for change to reduce occupational exposures or toxins at the industry level. It focuses on one mining community in Sudbury, Ontario, with a high cancer rate, and its reduction in occupational exposures. It explored the level of awareness of occupational exposures from the perspective of industry and worker representatives in some of the deepest mines in the world. Although awareness may be necessary, it is often not a sufficient impetus for change, and it is this gap between awareness and change that this study explored. It examined the awareness of occupational disease as an impetus to reducing toxic exposures in the mining sector, and explores other forces of change at the industrial and global levels that have led to an impact on occupational exposures in mining.

**METHODS:** From 2014 and 2016, 60 interviews were conducted with individuals who were part of, or witness to the changes in mining in Sudbury. From these, 12 labour and 10 industry interviews and four focus groups were chosen for further analysis to gain a deeper understanding of industry and labour's views on the changes in mining and the impact on miners' health from occupational exposures. The results from this subsection of the data is the focus for this paper.

**RESULTS:** The themes that emerged told a story about Sudbury. There is awareness of occupational exposures, but this awareness is dwarfed in comparison to the attention that is given to the tragic fatal injuries from injuries and accidents. The mines are now owned by foreign multinationals with a change from an engaged, albeit paternalistic sense of responsibility for the health of the miners, to a less responsive or sympathetic workplace culture. Modernization has led to the elimination, substitution, or reduction of some of the worst toxins, and hence present-day miners are less exposed to hazards that lead to occupational disease than they were in the past. However, modernization and the drop in the price of nickel has also led to a precipitous reduction in the number of unionized miners, a decline in union power, a decline in the monitoring of present-day exposures, and an increase in non-unionized contract workers. The impact has been that miners have lost their solidarity and power to investigate, monitor or object to present-day exposures.

**CONCLUSIONS:** Although an increase in the awareness of occupational hazards has made a contribution to the reduction in occupational exposures, the improvement in health of miners may be considered more as a "collateral benefit" of the

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changes in the mining sector. Multiple forces at the industrial and global level have differentially led to an improvement in the working and living environment. However, with the loss of union power, the miners have lost their major advocate for miner health.

**Keywords:** Knowledge transfer and exchange, occupational cancer, community-based research, knowledge to action, city level analysis

## 1. Introduction and background

Mining is a fundamental part of the industrial landscape with miners, and the metals, minerals, and rocks they extract being foundational to all aspects of culture, the economy, and the social and political fabric. However, the miners who extract this wealth work in highly hazardous environments and over the decades, thousands of miners have died from explosions, leaks of poisonous gases, collapsing of mine stopes, flooding, or general mechanical errors. Despite the attention that these traumatic deaths rightly receive, more miners are dying from occupational diseases and cancers, such as asbestosis, mesothelioma, silicosis, lung, nasal and gastrointestinal cancers, chronic obstructive lung disease, and emphysema. Miners are dying from occupational diseases in orders of magnitude higher than from injuries, due to their cumulative exposure to chemical and biological agents underground as reported by Del Bianco and Demers (2013).

The focus of this study is on the Ontario mining sector where there is a significant and growing discrepancy between a much larger number of occupational disease fatalities in comparison to fatalities from injuries and accidents. In the last ten years, claims for workers' compensation for Ontario miners have been accepted for 24 traumatic fatalities, but 193 fatalities from occupational diseases [1]. This is a trend that is repeated across Canada, where between 1997 and 2010, there was a 216.4% increase in accepted claims for mesothelioma, a 575.0% increase in accepted claims for lung cancer and a 512.5% increase in accepted claims for other cancers [2]. Their analysis shows that the pattern in Ontario is even more striking, with cancers "far surpassing traumatic injuries in more recent years," accounting for 63% of all work-related fatality claims in 2010, compared to 23% of accepted claims for traumatic injury deaths.

The trend world-wide is harder to demonstrate since estimating the global burden of work-related deaths is quite difficult and estimates are likely under represented [3]. Given these limitations, it has been

estimated that between 2 and 2.3 million deaths annually are work-related [3, 4]. Recent analyses have estimated that most of these are likely the result of occupational diseases [3, 4]. In industrialized countries, the ratio of work-related deaths due to disease versus injuries is higher than in developing countries [4]. In the US in 2007, there were estimated to be more than 5,600 work-related deaths from injuries and more than 53,000 from work-related disease [5].

This study attempts to gain a deeper understanding of the impetus for change to reduce occupational exposures or toxins in the mining industry. It focuses on one mining community in Sudbury, Ontario, with a high cancer rate, and its reduction in occupational exposures. It explores the level of awareness of occupational exposures from the perspective of industry and worker representatives in some of the deepest mines in the world. Although awareness may be necessary, it is often not a sufficient impetus for change, and it is this gap between awareness and change that this study attempts to examine at the industry level. It examined whether awareness of occupational disease was an impetus to reducing toxic exposures in the mining sector, and explored other forces of change at the industry and global levels that may have led to an impact on occupational exposures in mining.

This study builds upon an examination of another city's reduction in occupational exposures. It was based in the city of Sarnia which is in south-western Ontario, close to the city of Detroit in the U.S. that has the highest rate of mesothelioma and lung cancer in Ontario. It is known as the petrochemical centre of Canada. The study examined the work of the community and unions to raise awareness of workers dying from asbestos exposure [6]. A large number of workers who had worked in two very toxic work environments with concentrated asbestos exposure were afflicted with high rates of lung cancer and mesothelioma. The unions and the community mobilized to get compensation for these men and their families. The city of Sarnia seemed to be such a unique case that a further study was deemed necessary to act as a

comparison to Sarnia, and hence a study was initiated in the City of Sudbury that has the second highest cancer rates in Ontario.

Sudbury is a city of 160,000 in north-eastern Ontario. It is situated in a valley created by a meteorite that hit the earth 1,850 million years ago [7]. The impact of the meteorite left the area richly endowed with nickel, copper, and precious metals [7]. Sudbury has been a mining town for more than a 125 years, with the first copper sulphide deposit detected in 1883 [7].

Historically, the two largest mining companies in Sudbury have been Inco (about 80% of production), which was bought out by the Brazilian company Vale in 2006, and Falconbridge (about 10–20% of production), which was bought out by the Swiss company Xstrata in late 2006 (which was in turn bought out by Swiss Glencore in 2013). Between the two companies, in the 1970s, they employed over 25,000 workers, over 25 percent of the Sudbury population (which was most of the male workforce). Since the 1970s, Inco and Falconbridge went from controlling 25% of world-wide nickel production, to being just 5% of the world market and having little control over the price of nickel [7].

As mentioned, Sudbury was chosen as this study's focus because it has one of the highest rates of occupationally-related disease in Canada, including lung and nasal cancer, respiratory disease (including silicosis), and chronic obstructive pulmonary disease (COPD) (Fig. 1). One of the reasons for this elevated rate was the high exposure to a mixture of nickel

compounds, such as nickel sulfides (including nickel subsulfide), nickel oxides, and nickel carbonyl from a sintering plant that separated sulphur from the nickel-rich ore that operated in the north Sudbury area of Copper Cliff from 1947 to 1963. It was a highly toxic environment that led to cases of lung and nasal cancer several times the provincial average [8]. This dirty, toxic environment has led to hundreds of lethal lung and nasal cancers, and other respiratory diseases amongst the sintering plant's workers.

Another major source of cancer was from working in the uranium mines in Elliot Lake. For the years 1954 to 2007, the rate of lung cancer cases and deaths among Elliot Lake uranium miners was 30% higher than those of the Canadian population [9]. Sudbury and Elliot Lake are relatively close to each other (170 km), and there have been constant migrations of miners between the two cities depending upon the availability of work. Between 1928 and 1987, half of Ontario's hard rock miners had worked in multiple mines in the north, extracting different resources. Of the 39,000 nickel-copper miners in northern Ontario, 30% had also mined uranium in Elliot Lake [10].

Sudbury was also chosen for the study since it offered the opportunity to acquire a deeper understanding of the impetus for change to reduce occupational exposures or toxins at the industry level. Some of the changes that have had an impact on the health on miners include an increase in awareness of occupational diseases, modernization in production processes, and changes from globalization.

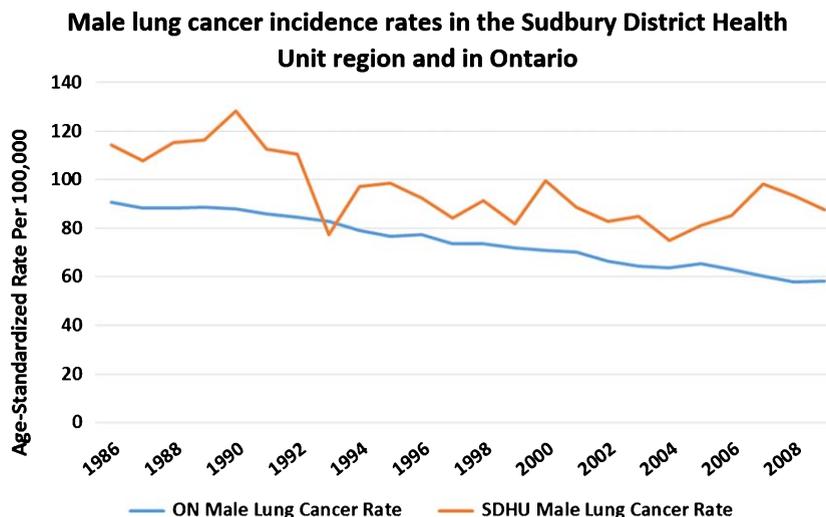


Fig. 1. Male Sudbury Lung Cancer Incidence in Sudbury vs. Ontario, 1986–2009.

## 2. Methodology

This qualitative case study examined a systematic approach to the reduction of toxic occupational exposures in the mining sector in Sudbury, Ontario. The inquiry was driven by an examination of whether awareness of occupational disease has led to initiatives to reduce toxic exposures in the mining sector, and explores the other forces of change in mining and at the global level that have had an impact on occupational exposures in the mining sector in Sudbury.

### 2.1. Sample and procedure

The analysis of the data was conducted from the theoretical perspective of social constructionism [11], with the idea that the two groups would view the forces of change that have had an impact on worker health from different perspectives and assumptions, and that the final story of what had happened and what was happening would be created from achieving an understanding of these different viewpoints. To this end, the study was informed by the qualitative analysis of interviews and focus groups. It also included a review and content analysis of newspaper clippings from Sudbury newspapers that covered labour action from 1970–1985 [12]. These clippings are located in the main library in Sudbury within the Mary C. Shantz collection. The clippings came mostly from the Sudbury Star, but also from the Globe & Mail, and Northern Life.

The study received ethical approval from the Waterloo-based Community Research Ethics Board. Interviewees were approached with a letter of information and a brochure describing the study. Each interviewee signed a letter of informed consent approving the interview, being recorded, and acknowledging the confidentiality of their comments.

In order to gain an in-depth understanding of the dynamics of this complex environment, during 2014–2015, 42 individual interviews and four group interviews (38 people participating) were conducted with industry representatives, members of organized labour, local politicians and academics, and community members. To achieve consistency, interviews were conducted face-to-face, by one person (DK) on the research team. There were a total of 31 hours of recording. Three of the interviewees were interviewed more than once; three people declined to be interviewed.

Interviewees were recruited through a snowball method; a few existing contacts in the unionized

labour movement, industry, and government representatives were initially contacted and interviewed, and they in turn helped identify and introduce the study to further key contacts. When these key people were identified, they in turn confirmed whether or not the expanding list included those whose opinions, experiences and positions could help inform the study. Most of the interviewees had lived in Sudbury and/or Elliot Lake during the years 1970–1985, had a connection to mining, and had witnessed the changes during the pivotal years. Many of them continue to live in Sudbury and remain involved in the development of the community, labour, or mining companies, and can reflect on the changes they have witnessed. A few could only comment on present-day experiences in the mining sector. Interviewees were divided into five groups: 12 miners; 10 industry representatives; nine community members; five academics; six politicians, and two labour and two union groups (38 people participating).

From the 42 interviews, 12 labour and 10 industry interviews, together with data from the four focus groups, were chosen for further analysis to gain a deeper understanding of industry and labour's views on the changes in mining and the impact on miners' health from occupational exposures. The results from this subsection of the data is the focus for this paper. The 12 workers that were classified as "labour" for this study, were members of one of the two unions that represent most miners in Sudbury, executives of the union locals or umbrella labour organizations with mining experience, and union representatives that helped miners get disability and compensation. The 10 interviewees that were classified as "industry" included 3 mining executives, 3 professionals who worked for mining companies, 3 representatives of mining associations, and an executive of a mining research company (multiple interviews occurred with three of these interviewees). The four focus groups were: 8 retired miners with very diverse mining experience; 5 union representatives; 5 industry employees who were part of a mining health and safety department; and 20 industry health and safety representatives attending a mining safety conference.

### 2.2. Conceptual framework

A semi-structured interview schedule was developed based on a previous conceptual framework developed by this research group. The Dimensions of Community Change Model (see Fig. 2) was based on the literature of community change [13–15] and

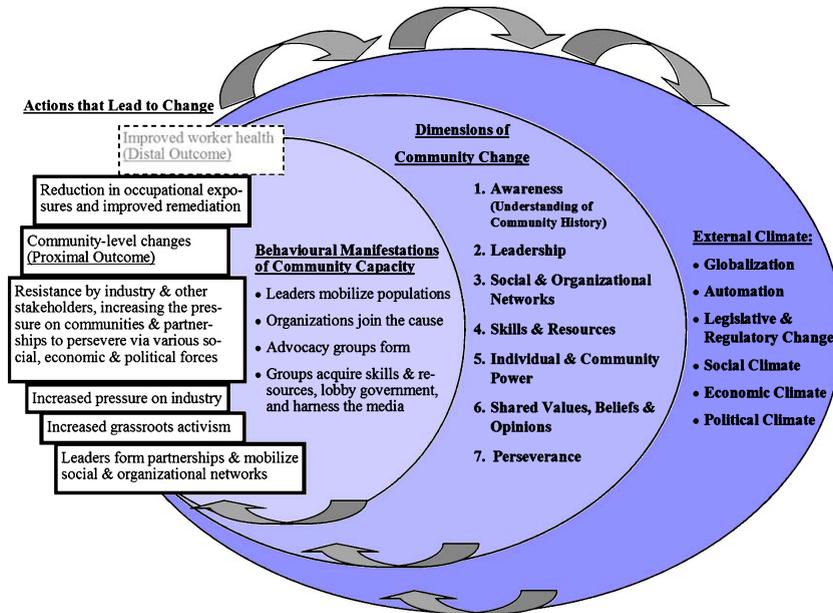


Fig. 2. The Dimensions of Community Change Model [6, 13–15].

the previous study on how the City of Sarnia had responded to rising awareness of very high rates of lung cancer and mesothelioma due to workers' high exposure to asbestos in the early 1990s [6]. There was ongoing analysis while the Sudbury interviews were being conducted, and as themes emerged, both the interview schedule and the conceptual framework for the study evolved. The questions that led the semi-structured interviews and focus groups were: whether they thought occupational exposure was still an issue with the mining industry or the unions; whether they thought that awareness of occupational exposures had had an impact on industry and its unions; what role had industry and the unions taken in regard to occupational exposures; what they considered the major forces for the changes they had witnessed; what were some key events in the occupational health and safety history of Sudbury and their impact; what changes had they seen since the 1970s including changes in the social, economic, political, environmental and occupational contexts; and what did they predict for the future of Sudbury's mining sector.

### 2.3. Data analysis

The interviews and group discussions were recorded and professionally transcribed, and entered into NVivo computer software. The initial content analysis [16] was conducted by two of the research

team through an immersion with the data and in discussion with each other. The first layer of analysis was conducted manually using matrices as a tool, and then supplemented with line-by-line coding using NVivo software by a team member (EH) who had not conducted the interviews. The data from the industry and labour interviews and focus groups were separated so that comparisons could be made between the two groups, and then comparisons were made across the two groups. A second layer of analysis was with the researcher who had conducted the interviews (DK); quotes were selected to represent the emerging themes.

Since the interview schedule was based on the variables of Dimensions of Community Change Model (Fig. 2), those variables created the foundation for the initial coding scheme. However as new ideas and concepts emerged, and their properties and dimensions were discovered during the course of the analysis [16, p. 101], new variables were added. In this way, a tentative conceptual framework was created. Four other researchers in the research team (DK, LH, KM, SK) listened (or re-listened) to all of the interviews, and were part of the discussions and interpretations of the data. As new themes emerged, new versions of the conceptual framework were created. In this way, and in conversation with the full research team, the Forces of Change Model was created (see Fig. 3).

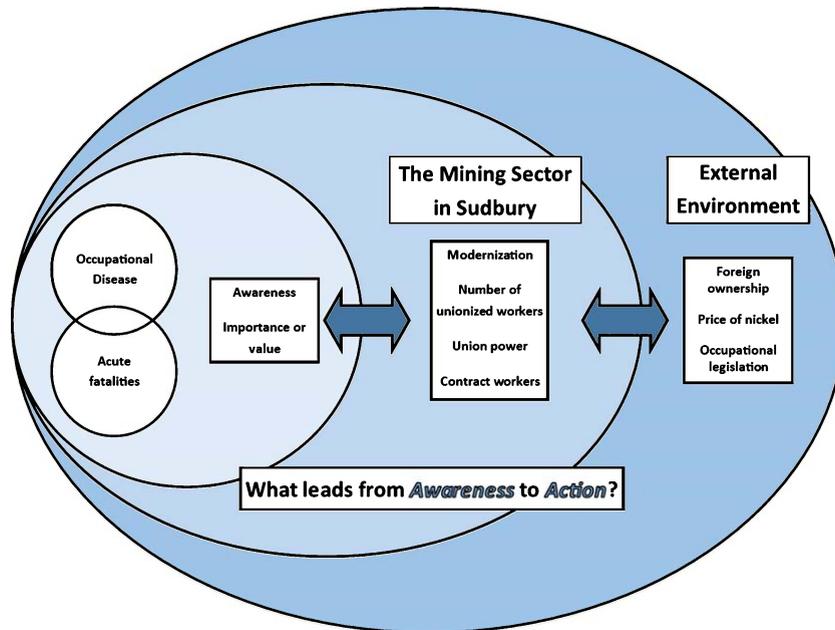


Fig. 3. The Forces of Change Model.

### 3. Results and discussion

The themes that emerged from our study were clustered into three categories: 1) Awareness and importance or value placed on occupational diseases versus fatalities from accidents; 2) The mining sector in Sudbury (including the history of labour action, the impact of modernization, the diminishing power of the unions, social networks, shared values regarding safety vs. profits, and leadership); and 3) The external environment (including the fluctuating price of metals, the impact of foreign ownership of the mines, and changes in occupational law). These concepts are discussed in the section below.

#### 3.1. Awareness of occupational diseases

All the interviews started with a question about whether there was an awareness amongst workers and industry representatives of exposure to hazards that could lead to diseases and cancer in miners. The question tried to help establish a link between the awareness of occupational exposures as a problem, and whether action has been taken to reduce these exposures as a result of this awareness.

##### 3.1.1. Awareness of occupational exposures has increased over the years

Interviewees from both groups said that present-day awareness of occupational exposures is high

in this dangerous mining environment, and that the work-relatedness of diseases and cancers is evident. The interviewees from the worker group said that workers have been aware of the hazards inherent in their jobs for decades, due particularly to the activist work of Homer Seguin in the 1970s and 1980s to raise awareness of the high rate of cancer fatalities amongst gold and uranium miners.

In order to examine whether awareness of occupational exposures is a relatively new phenomena, a review and content analysis of newspaper clippings from Sudbury newspapers that covered labour action from 1970–1985 [12] showed that awareness of and action taken on occupational disease (rather than fatalities from accidents) is probably more a reflection of present-day awareness. In this time period, occupational disease only received coverage in two circumstances. First, when there were reports on the Ham Commission that highlighted that workers were ill and dying from exposure to silicosis and radiation in the uranium mines of Elliot Lake. The other was a discussion about the need to establish an occupational health clinic in Sudbury (which was opened in 1992). Homer Seguin's autobiography, "Fighting for Justice and Dignity: The Homer Seguin Story" that highlighted the illness and deaths from exposures in the sintering plants, was published in 2008.

Interviewees agreed that there has been an increase in awareness of the importance of occupational

disease. An industry executive commented on increased awareness and improvement in attitude towards occupational health and safety, in general, over the decades: *“As society’s standards change outside of the workplace, so do attitudes towards what’s acceptable in the workplace. There’s a change in conversation about how things should work.”*

### 3.1.2. Awareness of fatalities from accidents dwarf those from fatalities from occupational disease

The imminent danger and a number of recent double fatalities at both the Vale and Glencore mines from injuries of young workers, raised the importance of mining fatalities for both labour and industry during the study. In 2013, there were three fatalities, in 2014 there were six, and in 2015 there were five [17]. There were four fatalities in the Sudbury area during the time of this study, and these fatalities were very much on the minds of most of the interviewees. Even those who expressed awareness of occupational exposures, noted that these immediate and horrendous fatalities mostly eclipsed the concern for diseases and cancers that have a long latency period.

As a union executive said, *“What is really important is falls-of-ground [from the mine roof], or rock bursts, or ‘run-of-muck’ [when a blockage of sand and water explodes uncontrollably]. That’s the overwhelming priority or issue in mining. If someone is killed tomorrow...that’s immediate. That’s traumatic...But occupational disease is so quiet and silent.”*

Adding the voice of industry, an interviewee from that group said, *“There is great awareness [of occupational disease] in the mining industry. Everybody knows someone that was affected; friends that have died. But they’re fatalistic about it.”*

As a company representative stated, *“[Occupational disease] is subtle; it happens away from us. Fatalities from physical events are so striking. They catch our attention. So even though we say ‘zero harm’, I don’t think anyone high up in my company really considers occupational disease in the same breath as fatalities [from injuries].”*

However, this view was not shared by all. An industry interviewee argued that occupational disease was equally important as critical fatalities. As one said, *“I think cancer caused by the workplace is the same as being killed in an accident. Both are because you went to work.”*

### 3.1.3. Dispute on who has led awareness of, and action on occupational exposures

The groups had different perceptions on who was more aware of the causes of fatalities, and hence which group had taken the leadership to improve occupational health and safety, including reducing exposures. No one person and neither group could demonstrate that they could take all the credit. It was more a diffuse leadership. The union representatives said worker fatalities affected them directly, and hence without their actions, change would not have occurred. As one union activist said: *“Inco was always the one that killed over 3,000 guys since they started operating in late 1800s. We’ve got their names on a record. They killed over 3,000 men in that operation. And up until quite recently, they were killing 3 or 4 every year, that’s just the way they did stuff.”*

The union representatives did not think industry had been adequately engaged with occupational disease. As a union representative said: *“It’s been on our agenda for ever, but it’s only on our radar. We know that the companies and the government are more than happy to collude with each other. Our people die from [occupational disease]. So to us, it’s part of health and safety. We have experienced Elliot Lake, the gold mines and the sintering plant!”*

However, all the industry representatives expressed strong distress about the recent critical fatalities. As one interviewee in this group said, *“Mining is run by human beings who also have families and wives and children. They do have a very strong concern for health and safety... I don’t know one person who doesn’t care about health and safety. We all care.”*

Interviewees from both groups mentioned with pride the past actions taken by key leaders in their groups to improve working conditions in the mines. When these groups talked about leadership, they made it clear that the link between awareness and action on occupational disease had been achieved through their leaders’ trailblazing.

The miners look back on their union leadership and the battle that was waged for worker health and safety. They talked of the advocacy of Homer Seguin, but also about the present international President of the Steelworkers Union of North America, Leo Gerrard. However, these unionized workers mentioned the need for solidarity from a larger membership to support their leaders. As a union activist stated, *“In 99.9% of the time, one person doesn’t make a difference. Not unless they’re part of something else... Individually, you can always be separated off.”*

*You can always be bought off. You can be offed off, or be overwhelmed..."*

Industry also took ownership of leading the movement to improve the lives of workers and decrease their occupational exposures. *"My concern is that there's not an acknowledgement that at times industry does lead change in society,"* said an industry executive. *"There are countless examples of companies doing the right thing, not because they had to, but because someone in leadership felt a moral obligation to act."* Adding to this comment, another executive said, *"When the company's director of medicine became aware of the large number of nasal sinus cancers...the company began to change the process. It wasn't the unions. It wasn't the government. It was the company through its medical [doctors] who were responsible and diligent in trying to prevent cancer."*

A senior mining executive who is highly regarded in the sector highlighted the need for leadership on occupational health and safety (over the profit motive). *"There shouldn't be a dichotomy. In my view, safe operations are the most productive operations because in the end, you cannot sustain productivity if you're hurting workers. The two don't go together. And if you look at the great companies in the world that have been the most productive, they are invariably the safest. ... When you start to care about each other and you treat each other as human beings, you'll find a different result. And you will deliver safety, you will deliver productivity, you will deliver competitive costs. All those pieces fit together."*

However, both industry and workers expressed concern at the lack of emerging "statesmen" to take the place of the giants of the past. *"We used to have them. We used to have great leadership. Less so today than we did back then, that's for sure. There were giants back then! But now you can't find them. We usually 'kill off' our leaders before they can even emerge as real leaders,"* said an industry representative capturing what both union and industry said. *"Part of the reason is globalization,"* he continued. *"Most of mining is now owned by people headquartered in Zurich or Brazil. When the leaders were in Canada, they had great influence on what was happening in the country. They were nationalists; they weren't just managing companies. They were building a country."* This fear about a lack of future leadership was also expressed by the union representatives. The fear was expressed that few strong leaders are emerging in the mining sector, and even if there were some, they would still be missing the

solidarity of a large union membership to support them.

Heightened awareness of occupational disease and leadership from the unions and industry has had an effect, but as the previous mention of globalization indicates, the interviewees also mentioned other forces of change within the mining sector in Sudbury and in the external environment that have had an effect on the health of miners.

### *3.2. Impact of changes in the mining sector on occupational exposures*

Other changes that have had an impact on the health of miners in the mining sector are the modernization of mining technology and processes, as well as external forces including the fluctuation of the price of nickel, globalization and the buy-out of the mining companies by foreign owners, and the changes in occupational health and safety legislation (see Table 1).

#### *3.2.1. The health impact of the modernization of the mining sector*

Sudbury has had many and some very long union strikes, shutdowns and layoffs that have all had an impact on the health of miners (see Table 2). The strike of 1978-1979, which lasted 11 months, was followed by a 10- and 8-month shut-down of the mines at Inco and Falconbridge in 1982 [7, 18]. Nickel prices were down and the contract with the unions had expired. A large number of miners were laid off during the shutdowns, and employment numbers have gone down steadily from then. Numbers are difficult to track with certainty, but the number of unionized miners has probably fallen from a high in 1971 of over 25,000 miners employed by Inco and Falconbridge (some said that the numbers were as high as 30,000 miners), to a low of 5,000 (or even as low as 3,000) unionized miners in the mines now (this does not reflect the number of contracted non-unionized workers also working on the premises) [7].

The companies chose to use the strike and shut-down in the early 1980s to re-mechanize and re-tool. The upgrading was also an opportunity to reduce SO<sub>2</sub> emissions and reduce the mines' dependence on expensive and unpredictable labour. It is possible to plot the correlation between employment, SO<sub>2</sub> emissions, and nickel production before these pivotal changes, and then the decoupling of employment numbers and productivity after 1984, as employment

and SO<sub>2</sub> emissions went down while production was maintained or increased (see Fig. 4).

Although an increase in the awareness of occupational hazards has made a contribution to the reduction in occupational exposures, the improvement in the health of miners could be considered more as a “collateral benefit or damage” of the systemic changes in the mining sector. Mechanization, automation, technological change and more recently, the use of robots in mining, has transformed the underground mining environment. There has been elimination, substitution, or reduction of some of the worst toxins, and hence lower exposures for present-day miners. However, modernization has led to a reduction in the number of unionized miners, decline in union power, and an increase in contract workers. As an industry executive commented, *“There’s more computerization, more robotics, and now man-less mines. [From this], processes become more efficient. And yes, there will continue to be an erosion of employment.”*

So although the modernization may have improved the mining environment for those who still work underground, the number of workers is now a fraction of what it was. Although there are fewer workers now exposed to occupational toxins, there has been a significant loss of well-paying, unionized jobs. *“It completely changed the nature of the work that people do,”* said a union member. *“Some would say that when you introduced automation and new technology, it improved the workplace. It makes it less hazardous. But what you’ve done is you’ve introduced new problems and created new [social] issues.”*

The drop in unionized workers has also led to a decline in resources and capabilities of the unions. Unions are less able to engage in the activism or awareness-raising on occupational fatalities as they did in the past, which all the labour interviewees mentioned as critical. The unions also no longer have the power they once had to negotiate with industry. As a union activist put it, *“The employer won’t do it [improve occupational health and safety] if you can’t demonstrate you’ve got some solid unanimity of support from the workforce. You have to have that. You have to be able to demonstrate that. The reason why the Steelworkers were so able and so powerful in the mining industry is that they could deliver. Particularly through the 70’s and 80’s, they could deliver people. They knew they had the support of the membership on this stuff.”*

A third consequence of the decline in union power is the rise in non-unionized contract workers. Vale

and Glencore have both outsourced production to contractors and contracting companies. The interviewees reported that these contractors are doing more dangerous and highly exposed work in part because they are non-unionized and have low job security; it is presumed that these workers are reluctant to report unsafe work. They are also highly mobile, changing employers and locations depending upon where the work is. Consequently, it is difficult to track if, or when, or where they could have been exposed to toxins that might have a long-term effect on their health. There was a persistent theme amongst the worker interviewees that in general, unionized workers are more able to resist unsafe work than contract workers, and losing one’s unionized job would be a great loss. *“If we find that a job is too dirty and we raise too many concerns around it, well they’re going to contract out that work. So [the question is] do we expose ourselves to that hazard and keep the work, or do we not do that work and know it will get contracted out?”* said a union representative.

### 3.2.2. The health impact on miners from external forces

The health of Sudbury miners has also been affected by global changes that have occurred in the mining sector. The fluctuating price of metals, foreign ownership, and changes in occupational legislation have been major drivers of change.

The price of nickel is the indicator of the health of the industry, and the possibility of new investments; it has an indirect impact on the health of the mining sector and the employment of workers. Since nickel was essential for the production of munitions including tanks and guns, the price has skyrocketed at times of war (WWI, WWII, Korea, Vietnam, and the Cold War). However, it can drop equally precipitously when new metal ores are discovered, companies stockpile, or demand is low. Recently, in a 12-month cycle, the price of nickel, having been static for three decades, plummeted from a high in September 2014 of \$20,000 per tonne, to a low in July 2016 of \$8,000 per tonne [19]. As one industry representative said: *“It’s the mining boom-bust cycle! I’ve been in at least five of these, believe it or not. And this is not the worst. But when we go through the bust, we don’t think we’ll ever get out of it, but we always do. And when we’re in the boom, we never think it’s going to go down again. The definition of insanity is doing the same thing over and over again and expecting a different result!”*

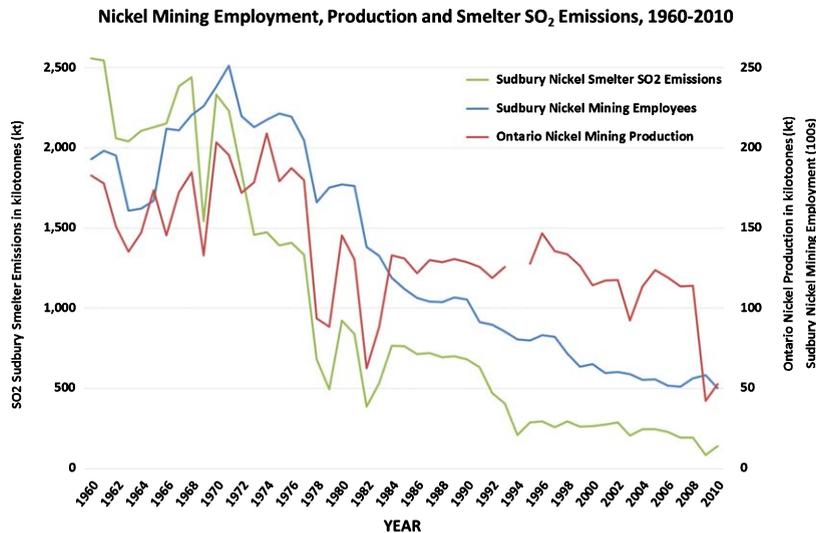


Fig. 4. Nickel Mining Employment, Production and Smelter SO<sub>2</sub> Emissions, 1960–2010.

The bust cycles have had a negative effect on the miners, their unions, and the mining companies. It has driven mining companies into bankruptcy and led to the layoff of unionized workers. Indirectly, it can have an impact on the resources available to focus on occupational exposures. “At \$4.50 a pound for nickel, everybody’s a bit fearful about what the future holds,” said an industry representative.

The change in ownership of the two major mining companies has also had an important effect on Sudbury’s mining sector and occupational risks in the mines. In 2006, Inco was sold to the Brazilian company, Vale, and Falconbridge was sold to a Swiss company, Xstrata Nickel. Yet one more change of ownership occurred in 2013 when Xstrata Canada was bought out by the Anglo-Swiss company, Glencore. Vale and Glencore are large multinationals with diverse holdings around the world. With these buyouts, the mining sector in Sudbury became a casualty of globalization, and went from being the world’s capital of nickel mining, to being just one of many international mines around the world and a very small part of their international owners’ holdings.

Despite a history of antagonistic labour relations, including regular and sometimes devastating strikes, a sentimental longing for the “good ol’ days”, however paternalistic they were, has emerged for “Mother Inco,” primarily because it was a Canadian company. Concerns about the transfer of ownership to Vale were expressed by both labour and the industry interviewees. Implicit in many of the comments was

the belief that foreign ownership meant less care for workers, including health and safety and occupational exposures.

In the words of one miner who has lived in Sudbury his whole life: “*The effect has been a massive cultural change with a foreign company coming in and trying to impose their set of values on a community that has not experienced this before. I think it’s caused a tremendous amount of stress on families, on workers, on community. It’s been counterproductive as to community involvement. With the previous mining company there was a lot of labour management community involvement. And that seems to have dissipated if not disappeared*”

Representing the thoughts of a number of the industry employees who were interviewed, one said, “*There has been a dramatic change... It’s very ‘dog eat dog’ in the company right now. When I talk to people who have worked for [the company] for 25 years or more, they say they’ve never seen anything like it. It’s depressing. It’s dehumanizing. We are told there should be no more innovating. We just need to get the nickel out of the ground. It’s very, very driven. In the last year a lot of people with 25 years of experience never made it to pension because they were let go just to cut costs.*”

Building on that, another industry representative said, “*I sense, and it’s only a sense, that the change is due to the fact that Vale came in expecting to make a lot of money on nickel, without a very good understanding of the culture that was built up in Inco, including the occupational health culture... Vale is*

Table 1  
Sudbury's timeline

Year(s)	Event
1970s	Industrialization, automation, and mechanization begun in the 1960s and continued in to the 1980s, influenced by the 1978 strike [7]. Mining in Sudbury began its decline [7]. Inco employed over 20,000 workers at its height [7]. Falconbridge employed between 4,000 and 5,000 workers for most of the 70s [7].
1970	The Ontario government allowed women to work at the mining surface [7].
1971	The international demand for nickel dropped [7]. Falconbridge's market share rose from 9 to 14% [7].
1972	The Inco superstack was activated [7]. Inco expanded its profitable nickelferrous pyrrhotite treatment plant for the third time [7]. The Inco Coniston smelter closed in response to environmental concerns [7]. The Falconbridge pyrrhotite plant closed due to environmental concerns [7].
1973	During the oil crisis, it cost much more for the energy to smelt and refine in Sudbury and Manitoba [7].
1975	Employment in the mining industry began to decline [20].
1976	The Ham Commission Report was released [21]. Falconbridge's Lockerby Mine was opened [7]. Inco Limited became the new name of the International Nickel Company of Canada, Limited [7].
1977	Inco laid off 3,000 workers [7]. Falconbridge declared its first corporate losses [7].
1978	Falconbridge's Sintering Plant was closed due to environmental concerns [7]. Women were allowed to work underground [7]. Operation of Inco's new smelter and Falconbridge's new sulphuric acid plant began in Sudbury. The plants aimed to reduce sulphur dioxide emissions [7].
1978 Sept -1979 June	Inco was the first major producer of nickel in the world. There was a threat that Inco would leave Sudbury for one of its international mines during the 1978-79 strike [22].
1979	Nickel began trading on the London Metal Exchange and therefore the price of nickel was no longer set by Canadian mining companies; world demand was the deciding factor [7]. An oil crisis lasted for 4 years [7]. October: The Occupational Health and Safety Act: A number of changes to worker health and safety regulations were made to the act in accordance with recommendations from the Ham Commission Report [21].
1981- 1983	Falconbridge posted corporate losses [7].
1981	A recession led to a drop in nickel demand [7].
1982	Inco shut down operations for 9 months for plant and mine modernization [23]. This was the second time the company did not turn a profit (since 1932) [7]. 950 Inco workers were either laid off or took early retirement packages [18, 23]. Falconbridge shut down for eight months and laid off 1000 workers [18]. Name changed to Falconbridge Limited [24]. Sudbury producers only produced 10% of the world's nickel, down from the Second World War when they commanded 90% of the world's [7].
1984	Inco downsized its employees by more than half [7]. Inco's Port Colborne Nickel refinery closed, and transformed to refining cobalt and precious metals [7].
1985	Ontario released environmental legislation requiring companies to reduce emissions [7].
1986	Falconbridge acquired Kidd Creek, a major copper and zinc producer [7]. Garson mine closed due to a rock fall [7]. Falconbridge downsized its employees by more than half [7].
1987	Demand began to rise for stainless steel; some nickel producers worldwide had closed and there was a limited supply of stainless steel scrap. Inco and Falconbridge begin to recoup costs [7].
1988- 1993	Falconbridge made efforts to conform to the 1985 Ontario Environmental Legislation by introducing new capital projects. Its labour force continued to shrink [7].
1989	Inco won the silver medal for productivity in the Canadian Business Excellence Awards. They upgraded their machinery, which made their processes more efficient and less energy intensive, resulting in lower production costs [7]. Inco and Falconbridge were starting to recoup costs – their profits were at \$1 billion CAD [7]. Falconbridge was acquired by Noranda Inc. and Trelleberg AB [7].

Orange – Global, Red – Inco/Vale, Purple – Falconbridge/Glencore/Xstrata, Yellow – Legislation/Government. \*\*Events reflecting more than one category are coloured partially in each of the representative colours\*\*.

*used to iron-ore mining which is strip mining – that's surface mining. Nickel is deep, hard rock mining – a completely different animal. From the time you drive your first shaft down to when you are lifting the ore up,*

*can cost maybe \$100 million. And Vale says, 'What are you talking about!'... And so the tendency is to try and do it for much less money than you would normally spend."*

Table 2  
Labour strikes in sudbury

Location	Mine Name	Beginning	End
Sudbury	International Nickel Co. of Can. (Mine, Mill and Smelter)	1958 Sept. 24	1958 Dec. 26
Falconbridge	Falconbridge Nickel Mines (Mine, Mill and Smelter)	1960 May 16	1960 May 20
Sudbury	International Nickel Co. of Can. (Sudbury area)	1966 July 14	1966 Aug. 8
Sudbury	International Nickel Co. of Can. (Sudbury area)	1967 Sept. 14	1967 Sept 17
Falconbridge & Onaping	Falconbridge Nickel Mines (Mine, Mill and Smelter)	1969 Aug 21	1969 Nov. 22
Sudbury	International Nickel Co. of Can. (Sudbury District)	1969 July 10	1969 Nov. 14
Falconbridge	Falconbridge Nickel Mines Ltd (Mine, Mill and Smelter)	1975 Aug. 21	1975 Oct. 31
Sudbury	International Nickel Co. of Can. (Sudbury area)	1975 July 10	1975 July 20
Sudbury	International Nickel Co. of Can. (Sudbury area)	1975 July 24	1975 Aug. 7
Sudbury	Inco Metals Co.	1978 Sept. 15	1979 June 4
Sudbury	Inco Ltd.	1982 June 1	1982 July 5
Falconbridge	Falconbridge Nickel Mines Ltd (Office Workers Local 6855)	1986 - 3 days	
Sudbury & Port Colborne	Inco Ltd.	1997 - 26 days	
Sudbury & Port Colborne	Inco Ltd	2003 June 1	2003 Aug. 28
Sudbury	Vale Ltd.	2009 July 13	2010 July 8

The third external force of change that was mentioned by the interviewees as having a significant effect on miners' health was labour legislation that has led to improvements in the mining sector. The fatalities from injuries and from occupational disease in Sudbury and Elliot Lake directly led to the establishment of the Royal Commission on the Health and Safety of Workers in Mines in 1976, which in turn, led to Ontario's provincial Occupational Health and Safety legislation in 1978. An Ontario Ministry of Labour Mining Review Panel [1] was taking place during this study. Many of the industry and labour interviewees for this study were involved in this Review. The Review was established as a response to the number of critical injuries and fatalities in Sudbury, but it also included an examination of occupational diseases related to mining. Eighteen recommendations emerged from the Review. The most significant recommendation on occupational exposures was that the Ministry of Labour should review the occupational exposure limits for silica, nitrogen dioxide and diesel particulate matter (DPM).

Legislative changes that demand higher standards of safety and higher standards of reduction in toxins are often regarded as the most significant of possible impacts from awareness of health and safety hazards, and are often the focus for unions' advocacy. However, regulations need to be supported by enforcement to be effective. Despite the long history of occupational health and safety legislation in mining, labour representatives expressed their concerns about the effectiveness of the legislation to protect workers' health. As one interviewee said, "*The leg-*

*islation is there, but it's not enough and it's a hard thing to change. It's been the same for years and years. The injuries are the same and the fatalities are all the same. We [the union] have limited ability to make regulatory change. Industry has to drive the change and of course, industry doesn't want to because their rates will go up. They just want the status quo.*"

#### 4. Limitations

The focus of the study is its major limitation. Case studies are by definition limited in their ability to be generalizable; the community of Sudbury was not randomly chosen; and only the opinions of a select number of key informants have been included. The key informants from industry and labour are only part of much larger number of interviewees and they came to this discussion with very particular viewpoints which are not necessarily reflective of the full dynamic of the changes that have taken place in Sudbury. As such, the social constructionist [16] approach taken to this study helped to orient these different viewpoints that came from different sources, and brought these viewpoints together to gain an understanding of the situation at hand.

Taking these limitations into account, this study is one of only a few studies that have looked at the awareness of occupational exposures from the perspective of industry and labour as an impetus for change, and no studies to this date have examined the social forces of change that have led to the reduction of industrial exposures in Sudbury.

These results can contribute to a wider analysis of the resources and leadership required for industries to make changes that will reduce occupational diseases, and contribute critical information for communities that wish to remediate their environments after damage from industrial exposures.

In conclusion, the study reinforces the idea that although awareness may be necessary, it is often not a sufficient impetus for change especially when the change that is required is the remediation of such a complex and potentially contested problem as occupational exposures in the mining sector. In this case study, other forces of change at the industrial and global levels have had a greater impact on the reduction of occupational exposures in mining than awareness alone could have achieved.

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### Conflict of interest

None to report.

### References

- [1] Ontario Ministry of Labour [Internet]. Occupational Diseases in Mines [Updated February 10, 2016; cited 2016 Nov 11]. Available from: <https://www.labour.gov.on.ca/english/hs/pubs/miningprogress/profile.php>
- [2] Del Bianco A, Demers P. Trends in compensation for deaths from occupational cancer in Canada: A descriptive study. *CMAJ* 2013;1(3):S91-6. doi:10.9778/cmajo.2013-0015
- [3] Driscoll T, Takala J, Steenland K, Corvalan C, Fingerhut M. Review of estimates of the global burden of injury and illness due to occupational exposures. *Am J Ind Med* 2005;48(6):491-502.
- [4] Takala J, Hämäläinen P, Leena Saarela K, Yun LY, Manickam K, Jin TW, Heng P, Tjong C, Kheng LG, Lim S, Lin GS. Global estimates of the burden of injury and illness at work in 2012. *J Occup Environ Hyg* 2014;11(5):326-37. doi: 10.1080/15459624.2013.863131
- [5] Leigh JP. Economic burden of occupational injury and illness in the United States. *Milbank Q* 2011;89(4):728-72. doi: 10.1111/j.1468-0009.2011.00648.x
- [6] Kramer D, McMillan K, Gross E, Kone Pefoyo AJ, Bradley M, Holness DL. From awareness to action: The community of Sarnia mobilizes to protect its workers from occupational disease. *New Solut* 2015;25(3):377-410.
- [7] Saarnien O. From meteorite impact to constellation city: A historical geography of Greater Sudbury. Waterloo, Canada: Wilfrid Laurier University Press; 2013.
- [8] Larmour A. *Until the End*. North Bay: WyterBlue Publications; 2010.
- [9] Navaranjan G, Berriault C, Do M, Villeneuve P, Demers P. Ontario Uranium Miners Cohort Study Report. Toronto: Occupational Cancer Research Centre; 2015. p. 123.
- [10] Arrandale VH, Berriault C, Lightfoot NE, Demers PA. Employment Mobility of Miners in Ontario, Canada and Implications for Exposure Assessment in Studies of Chronic Respiratory Disease and Lung Cancer. In: B25. Occupational respiratory diseases: Novel epidemiology and mechanisms. Vol. 245. Denver, Colorado: American Thoracic Society; 2015. pp. A2590-A2590. (American Thoracic Society International Conference Abstracts).
- [11] Berger PL, Luckmann T. *The social construction of reality: A treatise in the sociology of knowledge*. London, England: Penguin Books; 1966.
- [12] Krippendorff K. *Content analysis. An introduction of its methodology*. Third Edition. Thousand Oaks: Sage; 2004.
- [13] Minkler M, Vasquez VB, Tajik M, Petersen D. Promoting environmental justice through community-based participatory research: The role of community and partnership capacity. *Health Educ Behav* 2008;35(1):197-37.
- [14] Goodman RM, Speers MA, McLeroy K, Fawcett S, Kegler M, Parker E. Identifying and defining the dimensions of community capacity to provide a basis for measurement. *Health Educ Behav* 1998;25(3):258-78.
- [15] Freudenberg N. Community capacity for environmental health promotion: Determinants and implications for practice. *Health Educ Behav* 2004;31(4):472-90.
- [16] Strauss AL, Corbin JM. *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications; 1990.
- [17] Workplace Safety North [Internet]. Health and Safety News. North Bay: Workplace Safety North 2011 [Updated 2015 Nov 26; cited 2015 Dec 3]. Available from: [https://www.workplacesafetynorth.ca/news?field\\_sector\\_tid=All&field\\_news\\_tags\\_tid=119](https://www.workplacesafetynorth.ca/news?field_sector_tid=All&field_news_tags_tid=119)
- [18] Clement W. *Challenge of class analysis*. Ottawa, Canada: Carleton University Press; 1988.
- [19] Infomine Inc. [Internet]. Investment Mine: Mining markets and investment. Vancouver: Infomine Inc; [date unknown] [Updated date unknown; cited 2015 Nov 30]. Available from: <http://www.infomine.com/investment/metal-prices/nickel/1-year/>
- [20] Katary N. City was transformed in the early 1980s through collective vision and drive. *The Sudbury Star* [Internet]. 2013 Aug 3 [cited 2016 January 21]. Available from: <http://www.thesudburystar.com/2013/08/03/column-city-was-transformed-in-the-early-1980s-through-collective-vision-and-drive>
- [21] History of occupational health & safety legislation in Ontario [Internet]. Toronto, Canada: Public Services Health & Safety Association. [date unknown] [Updated 2010; cited

- 2016 January 21]. Available from: <https://www.pshsa.ca/wp-content/uploads/2013/02/LHSFCAEN0106-History-of-OHS.pdf.pdf>
- [22] Steven P. Une histoire de femmes: A Wife's Tale. Interview with Sudbury strike filmmakers [Internet]. [place unknown]: Jump Cut. [Updated 1981 December; cited 2016 January 21]. Available from: <http://www.ejumpcut.org/archive/onlinessays/JC26folder/IntOnWivesTale.html>
- [23] The 1982 winter. The Sudbury Star [Internet]. 2008 October 29 [cited 2016 January 27]. Available from: <http://www.thesudburystar.com/2008/10/29/the-1982-winter>
- [24] Falconbridge Limited history [Internet]. [place unknown]: St. James Press [date unknown] [Updated 2003; cited 2016 January 21]. Available from: <http://www.fundinguniverse.com/company-histories/falconbridge-limited-history/>