SECTION A

History of Geology, Mineral Exploration, and Environmental Damage

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Sudbury, Ontario, is one of at least five "Sudburys" in the world and probably the best known. It was named in 1882 by James Worthington in honor of his wife's birthplace in England. Mr. Worthington was the construction manager for the Canadian Central transcontinental rail line through the area.

The geological and anthropological histories of Sudbury, Ontario, are complex and fascinating, and some aspects are still being researched. In Table A.1, important milestones from earliest of time until the present are documented. Many of the events are discussed in the following chapters.

Ore was discovered in Sudbury in the 1880s. However, attempts to extract the copper was largely unsuccessful because of the high sulfides and the presence of the "devil's metal," nickel. Technology that was developed to recover the metals was not environmentally friendly, and the region suffered deep scars to the landscape from the mining and smelting activity. By the 1950s, Sudbury was famous as the world's largest producer of nickel and infamous as a region where the landscape has been devastated. Soil and vegetation were lost from tens of thousands of hectares of land surrounding the roast beds and the smelters. The scar was readily visible even from outer space (see Plate 1 following page 182). Decades later, the infamy was extended when it was shown that lakes at a considerable distance were acidified and grossly contaminated with metals. Fortunately, the story does not end there. Recent efforts related to reclamation, including emission reductions, have been positive. The latter chapters in this book demonstrate that, given the will and cooperation, environmental degradation can be abated over the short term.

Sudbury is not alone in its history of environmental degradation caused by mineral smelting. In fact, there are several "sister cities" in Russia where nickel smelting has created similar sites of environmental damage related to sulfur dioxide and metal particulate emissions. It is our hope that this book will provide a useful case history to assess progress toward environmental restoration.

TABLE A.1. Chronology of Important Events Influencing the Sudbury Region

	Time (years since present)
Formation/accretion of earth	4,600,000,000
Oldest known rocks of the Canadian Shield	3,920,000,000
Origin of life	3,400,000,000
Formation of Sudbury Basin	1,850,000,000
Beginning of mountain building period causing deformation of Sudbury Basin	1,800,000,000
End of mountain building period	1,630,000,000
Evolution of modern humans	1,000,000
End of last glaciation and formation of glacial deposits	10,000
Ojibways, Hurons, and Ottawas settle in the area	from 10,000
Evidence of first settlement Sheguindah	from 7,000
First European explorer (Champlain) (1615)	380
Chemical and physical properties of nickel recognized	250
Hudson Bay Trading Post established west of Sudbury Basin (1824)	171
First geological reconnaissance of the north shore of Lake Huron (Logan) (1849)	146
First mapping of mineralization in Sudbury area (1856)	139
Chicago fire exerts demands on Sudbury forests for lumber to rebuild (1879)	116
Discovery of mineralization at Sudbury during construction of transcontinental railway (1883)	112
First purchase of mining lands by Murray (1884)	111
First uses of corrosion resistant nickel steel (1885)	110
First smelting of Sudbury ores by roast heap (1888)	107
Thomas Edison stops exploring just short of discovering Falconbridge deposit (1901)	94
First geological map of Sudbury Basin (1905)	90
Ontario Royal Commission on Nickel (1915)	80
Austentite structure for stainless steel determined by Guillet (1915)	80
Damages by Sulphur Fumes Arbitration Act proclaimed (1921)	74
Founding of International Nickel of Canada Ltd. (Inco) (1928)	67
Formation of Falconbridge Nickel Mines Ltd. (1928)	67
Ontario government issues environmental control orders to reduce emissions from area smelters (1969)	26
First published concerns of long-range atmospheric damage from Sudbury (1970)	25
First Earth Day (1970)	25
Completion of Inco's "Superstack" and major emission controls (1972)	23
U.N. Stockholm conference on the environment emphasizes acidification pollution to lakes (1972)	23
First International Conference on Acid Rain at Ohio State University (1976)	19
Regional land reclamation initiated (1978)	17
Ontario government initiates Countdown Acid Rain program (1985)	10
First published evidence of reversal of acidification, Sudbury lakes (1986)	9
U.N. Local Government Honours Award to Sudbury (1992)	3
Legislated reductions in sulfur dioxide emissions achieved (1994)	1

"Exploration geology is the single most important and very first phase of mining. It begins by identifying what mineral/minerals is/are to be exploited, their geological setting, approximate size of orebody required and potential areas. Once these factors are considered, funds are required to finance the exploration project. Usually exploration companies list on stock exchanges to raise the required capital. Exploration begins by firstly gathering any possible data available on the resource, area, local geology usually from the geological survey, from satellite imagery as well as previous There are several parts of mineral exploration that a geologist participates in. Those parts are mainly: * Describing known mineral deposits * Based on it's characteristics, determine where the ore "will be" as the mine digs deeper * Finding new...Â In mines already under exploration, geologists describe the characteristics of the ore and try to predict where in that mine we should dig to find more ore. Basically geologists try to "follow" the mineralized zone as the mine digs deeper.Â , 36 years in both Oil and Gas exploration and Environmental Consulting.Â There is a branch of geology called Economic Geology which is the study of ore minerals and materials, how they form, their associations and what processes form them, and rocks in which they are found. Mineral exploration involves both percussion and rotary drilling that produce rock chips and intact samples of core. The diameter of mineral exploration drill holes (called slimholes) is generally much smaller than the diameter of either petroleum or geothermal wells.Â Drilling and access for drilling generally represent the most invasive aspect of mineral exploration. The environmental impacts of exploration activities could be significantly reduced by the development of drilling technologies that would minimize the footprint of these activities on the ground, such as the miniturization of drilling rigs, the ability to test larger areas from each drill site, and better initial targeting to minimize the number of holes. Different types of environmental damage and hazards inevitably accompany the three stages of mineral development. It is the purpose of this paper to present in a nutshell the negative effect on the environment of the activities involved in harnessing the minerals in Nigeria. An attempt will also be made to examine the possible precautions and remedies that can be applied in order to mitigate the effect of adverse environmental impact of mining activities.Â Thus in general, a greater damage is witnessed in the localities where tribute workers do only manual winning of minerals. For example, large-scale mining of tin and associated minerals in the Jos Plateau has resulted in a high degree of degradation of arable land, vegetation and landscape, as well as other environmental problems.