1. Introduction

Canada has been the world leader in uranium production since the early 1990s. In 2005, production amounted to 11 629 tU (tonnes of uranium metal) [1]. The Elliot Lake region of Ontario was once the center of production, but after the last of these facilities closed in 1996 all production now originates from the Athabasca Basin of northern Saskatchewan (Figure 1). The Athabasca Basin hosts the world’s premier, low-cost uranium deposits.

Average grades of the world’s two largest high-grade deposits, McArthur River and Cigar Lake, are 10 to 100 times the grade of deposits mined elsewhere. McArthur River has been in production since late 1999 and Cigar Lake is in final stages of construction with first production expected late in 2007. Remote, high-tech mining and processing methods are used to extract uranium from these deposits.

Canadian uranium producers are not only world leaders in production, but are also leaders in the development of environmentally responsible mining practices. All production facilities are strictly regulated by federal and provincial agencies. All effluents are treated prior to off-site release, and all tailings are managed and disposed of in mined-out open pits that have been engineered to serve as tailings management facilities.

![Location of Canada’s uranium production facilities, refining and conversion plants (black) and prospects for future development (italics).](image-url)
2. Production

Current production originates from four facilities operated by Cameco Corporation (Rabbit Lake, McArthur River and Key Lake) and CRI (McClean Lake). These operations have produced a combined total of between 10 400 tU and 11 650 tU per year since 2000, accounting for about 30% of global uranium mine production.

All ore extracted from the underground McArthur River mine is processed at the Key Lake mill, where Key Lake stockpiled mineralized waste rock is used to lower the grade of McArthur River ore to produce a mill feed of about 3.4% U. These facilities are currently licensed to produce about 7 200 tU per annum. A proposal to increase production by 18% at McArthur River and Key Lake is currently the subject of an environmental assessment. Cameco expects that it will take about two years to ramp up to the increased production level of over 8 450 tU/yr, pending receipt of regulatory approvals.

The McClean Lake production facility is currently licensed to produce about 3 000 tU per annum, although production since 2000 has not reached full capability, varying between 2 100 tU and 2 400 tU. The mill is being fed by ore mined from a number of deposits by open pit (JEB and Sue C have been depleted, while mining is underway at Sue A and Sue E). CRI and its joint venture partners are also continuing to test mine small deposits on the McClean Lake property using surface mining techniques. This “blind boring / jet boring” testing program began in 2005 and is slated to continue with mining of small the McClean Lake north deposit planned in 2006.

Production at the Rabbit Lake facility has declined from peak levels achieved in 1997 and 1998 (~ 4 500 tU per annum) as deposits suitable for open pit mining have been depleted. Since 2000, the facility has typically produced about 2 000 tU per annum from the Eagle Point underground mine. Recent surface and underground exploration has successfully identified additional reserves to extend mine life beyond 2007.

In addition to the efforts to increase or extend production at the existing mines and mills described above, two new mines are in the process of being commissioned in northern Saskatchewan over the next few years: Cigar Lake and Midwest.

While McArthur River is the largest high-grade uranium deposit discovered in the world to date (~160 000 tU; average grade of ~22% U), Cigar Lake is the second largest (~90 000 tU; average grade of ~16% U). The Cigar Lake mine is expected to be in production in late 2007 and, following a three year period required to ramp up to full production, will produce about 7 000 tU/yr. As with McArthur River, mining high-grade uranium in this groundwater saturated setting requires ground freezing and high-tech mining methods. Challenging ground conditions at Cigar Lake require the application of jet boring mining techniques designed specifically for Cigar Lake.

It is proposed that Cigar Lake ore will be processed at the McClean Lake and Rabbit Lake mill, with about half of the first phase of Cigar Lake ore to processed to completion at the Rabbit Lake mill, following partial processing at McClean Lake, pending receipt of regulatory approvals. A proposal to produce and ship on a dedicated haul road a uranium rich solution produced from Cigar Lake ore at McClean Lake for final processing at the Rabbit Lake mill is currently the subject of an environmental assessment. Production at McClean Lake is expected to be reduced slightly over the next few years as mill expansion and modification proceeds in order to prepare for processing high-grade Cigar Lake ore, expected in late 2007.

Mining of the smaller high-grade Midwest deposit (16 000 tU; average grade 4.6%U) is expected to begin as early as 2010, pending receipt of regulatory approvals. Midwest will be mined by open-pit and all ore will be milled at McClean Lake. It is anticipated that stripping some 185 m of overburden could begin in 2008 and that mining could take place over the course of 5 to 7 years. Further expansion of the McClean Lake mill will be required in order to process Midwest ore.

If all expansion and mine openings come to fruition, annual Canadian uranium production could amount to 16 000 tU or more by 2011.
3. Environmental Considerations and Public Acceptance

All currently operating uranium mines have been the subject of a comprehensive environmental assessment and review process, typically prior to receiving government and regulatory approvals to begin construction. Significant changes in development plans are also subject to environmental assessment as part of the licensing process. Mechanisms in place allow all stakeholders to provide input to all environmental assessments.

Uranium mining brings significant benefits and opportunities to local area residents in northern Saskatchewan, many of whom are of aboriginal descent. Uranium mining companies have implemented programs and scholarships to train and recruit residents of northern Saskatchewan residents for employment. In addition, companies have instituted policies for preferred sourcing of materials from northern suppliers (over $120 million in 2004 alone) [2] have acted as a catalyst in the development of northern based businesses, and are contributing to community health and vitality studies. In recognition of these and other efforts, the Canadian Council for Aboriginal Business presented a Gold Level Achievement award in progressive aboriginal relations to Cameco in February 2002.

Residents of northern Saskatchewan, representing 28 communities, are active participants in Environmental Quality Committees (EQCs). The EQCs serve as a vehicle for northern input on matters such as environmental protection, worker health and safety, and employment and business opportunities for northerners.

Recent survey results [3] show that the majority of Saskatchewan residents, particularly those in northern Saskatchewan, support the continuation of uranium mining in the province. Although support levels of about 80% were recorded in surveys conducted in December 2005 in all regions of the province, residents of Saskatoon and northern Saskatchewan are more likely to be strongly supportive of the industry than residents of areas further removed from the operations.

In addition to the development of environmentally sustainable practices in operating mines, it is important to note that the closed uranium mines in Canada have been successfully decommissioned and rehabilitated, in particular in the Elliot Lake region of Ontario, the centre of Canadian uranium mining for over 40 years. Uranium producers have spent over $CAN 100 million on the decommissioning and reclamation of these facilities, and results of comprehensive monitoring programs [4] show that the decommissioned facilities are performing as designed. In addition, governments are working to ensure that licensing and decommissioning of the few legacy uranium mines that have not been decommissioned to current standards will be dealt with in the near future.

4. Exploration

The principle exploration target in Canada remains the Athabasca Basin, but activity has also been reported in other territories and provinces, such as Nunavut, the North West Territories, Yukon, Quebec, Newfoundland and Labrador, Alberta, Ontario, and Manitoba. As many as 90 junior companies have joined the majors in this revived uranium exploration activity, a sector that had seen little activity for over 20 years.

Natural Resources Canada estimates that some $CAN 81 million (M) was spent on uranium exploration in Canada in 2005 and the Government of Saskatchewan estimates that about $CAN 67 M was spent in the Athabasca Basin alone that same year [5]. Both figures represent dramatic increases from the 2004 figures of $CAN 44 M nationally and $CAN 31 M in Saskatchewan. Major exploration programs are being conducted by producers Cameco Corporation and AREVA subsidiary COGEMA Resources Inc., as well as UEX, and a host of other junior companies that joint venture with themselves or the producers. By the end of October 2005, over 4.5 M ha in Saskatchewan were under mineral disposition. Exploration programs ranged from boulder prospecting to state-of-the-art geophysical prospecting for deeply buried deposits and diamond drilling of favorable geologic structures and for deposit delineation.

Although the majority of the ongoing exploration activity is in the eastern part of the Athabasca Basin, where the major deposits and production centers are located, there is activity through central and western
portions of the Basin as well. One significant discovery has already occurred in the south central portion of the Basin early in this recent exploration boom, the Millennium deposit (~20 000 tU grading at over 2%U), which is now advancing toward the pre-feasibility stage [5]. The Millennium deposit is located southwest of the McArthur River mine.

Other promising preliminary results include significant high-grade intersections at properties in the west central portion of the Athabasca Basin, such as Shea Creek, where numerous showings have been reported, including for the first time basement hosted mineralization. Promising results have also been reported at the far western margin of the basin, in the province of Alberta, and far northern portions of the Basin, stimulating joint venture partners to stake new ground and initiate new drilling programs.

The most intense exploration efforts are however situated near the currently operating production facilities. Work continues at Moore Lake, situated between McArthur River and Key Lake, where drilling has yielded favorable results. Southwest of Rabbit Lake, efforts at the large Hidden Bay property are focused on establishing a NI 43-101 compliant resource estimate for one of the shallowest (15 m to 30 m below surface) undeveloped uranium deposit in the Basin. Drilling is also being conducted at the previously defined nearby deposits, where drilling programs have also been designed to test the historic resource base to produce a NI 43-101 compliant resource estimate.

In addition, exploration by the majors on their existing production lease properties has also produced promising results. At the Rabbit Lake Eagle Point underground mine, brownfield exploration programs, restarted in 2003 after a 10-year hiatus, resulted in the delineation of over 3 800 tU of reserves and resources in 2005, extending the life of the mine beyond 2007. CRI is also continuing the search for additional deposits on its McClean Lake property. McClean Lake joint venture partner Denison Mines Inc. is also conducting exploration on property that surrounding the McClean Lake lease. A new NI 43-101 compliant resource assessment for the nearby Midwest deposit resulted in increased resources (~16 000 tU grading at 4.5%U) and an expanded exploration program in an area to the north of the Midwest deposit has returned encouraging results.

5. **Jurisdiction, Regulation and Mine Development**

Under the Canadian Constitution, natural resources are owned by the provinces or by the federal government if they are on federal lands north of 60° latitude. The provinces have jurisdiction over exploration activities within their borders and for most commodities have jurisdiction over mine development and production, including operations, conventional health and safety matters and environmental protection.

Uranium falls under federal jurisdiction, starting at the mine development stage, and federal jurisdiction takes precedence if there is any conflict. Although the resources are owned by the provinces and exploration is under provincial jurisdiction, once a company starts to develop a deposit into a mine it becomes subject to federal laws and policies.

The nuclear industry (fuel cycle facilities, reactors, and nuclear research and development) falls exclusively under federal jurisdiction. The principal pieces of legislation governing the uranium industry are the Nuclear Safety and Control Act, the Canadian Environmental Assessment Act and the Export and Import Permits Act. Each one of these Acts has one or more detailed sets of Regulations pursuant to it. Three Ministers are responsible for federal policies affecting the nuclear industry: the Minister of Foreign Affairs, the Minister of International Trade and the Minister of Natural Resources.

Canada has a mature nuclear regulatory system and all aspects of the nuclear fuel cycle, including trade, are strictly regulated to international standards. The Canadian Nuclear Safety Commission (CNSC) is an independent federal body that regulates all aspects of the nuclear industry, including uranium mining and milling. The CNSC reports to Parliament through the Minister of Natural Resources.

The CNSC administers *The Nuclear Safety and Control Act* and it is also the lead agency in administering *The Canadian Environmental Assessment Act* when it comes to uranium or nuclear developments. All exports of nuclear substances, including uranium, require export licenses issued by the CNSC under *The Nuclear Safety and Control Act* and export permits issued by International Trade Canada (ITC) under *The
Export and Import Permits Act. In practice, all export applications are jointly administered by the CNSC and ITC.

There are some important federal policies affecting the uranium industry. One of these, an important part of Canada’s foreign policy, is Canada’s Nuclear Non-Proliferation Policy, in which Foreign Affairs Canada has the lead role. This policy is implemented by the CNSC through its administration of the export license and export permit process.

In addition there is the Non-Resident Ownership Policy (NROP) in the Uranium Mining Sector. There are currently no restrictions on foreign companies conducting U exploration in Canada. However, at the time of first production, the NROP requires that the project be majority Canadian-owned, or Canadian-controlled, as defined by the Investment Canada Act (Canadian-owned in general means more than 51% of the voting rights in joint venture partnership, whereas Canadian-controlled in general means 50% plus one share, although other arrangements are possible if the mine is operated by a Canadian entity). The NROP was last revised in 1987 and remains in effect today. Exemptions were granted for the McClean and Midwest projects in the early 1990s when it was demonstrated that there was no Canadian interest in investing in these developments at that time.

Companies are encouraged to consult early and often on their activities and plans with the relevant government departments. They also consult with the relevant provincial or territorial authorities, and with any aboriginal groups likely to be affected by their work. The Canadian uranium industry has earned a reputation for conducting its business in an environmentally and socially responsible manner. Close consultation plays an important role in acquiring such respect and it benefits both the industry and government and is important for the industry to obtain a “social licence” to operate.

6. Conclusion

Canada is the world leader in uranium production and is well positioned to continue leadership given the size of the defined low-cost resource base, the large and thus far little-explored geological provinces with good prospects for additional discoveries, and federal government policies that support the development of uranium mining and milling operations. Canadian uranium producers are also leaders in the development of environmentally sustainable mining practices and have implemented innovative programs to promote local participation in the development and operation of their uranium mines and mills.

7. References


