



THE McCLEAN LAKE URANIUM PROJECT

J.R. BLAISE
COGEMA,
Velizy, France

Abstract

The McClean Lake Uranium Project, located in the northern part of Saskatchewan, consists of five uranium deposits, Jeb - Sue A - Sue B - Sue C - McClean, scattered in three different locations on the mineral lease. On 16 March 1995, COGEMA Resources Inc and its partners, Denison Mines Ltd and OURD (Canada) Co Ltd, made the formal decision to develop the McClean Lake Project. Construction of the mine and mill started during summer 1995 and should be finished by mid 1997. Mining of the first deposit, Jeb started in 1996, ore being currently mined. The start of the yellowcake production is scheduled to start this fall.

1. LOCATION

The McClean Lake Project is located in the northern part of Saskatchewan, near the eastern margin of the Athabasca Sandstone basin, approximately 750 km north of the city of Saskatoon (Fig. 1). The nearest operating mine is Rabbit Lake, only 20 km to the Southeast of McClean. Key Lake is about 180 km Southwest, while the new projects of Cigar Lake and McArthur River are respectively 60 and 110 km from McClean, the Midwest deposit being located 20 km to the west [1].

Access is by road and by air to a private commercial airport at Points North Landing, a 30 minute drive from McClean.

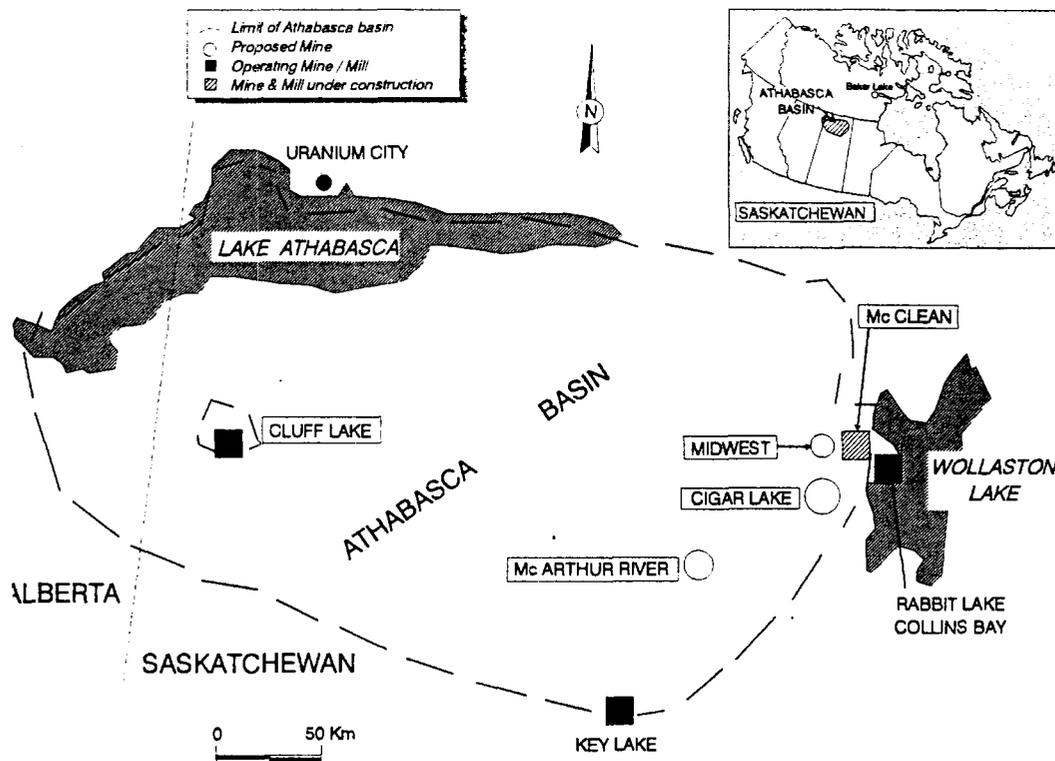


FIG. 1. Saskatchewan uranium deposit.

2. PROJECT HISTORY AND OWNERSHIP

The McClean Lake uranium deposits were discovered in the 1980's by the Wholly Joint Venture, which included Canadian Occidental, Inco and Total Minatco.

In 1990, Total Minatco became the sole owner of the property, which was renamed the McClean Lake project. The project was wholly owned by Total until April 1992, when Denison Mines Ltd and OURD (Canada), which had a consolidated stake of 45% in the Midwest project, and Total executed an agreement, which allowed each party to cross interests in the other's project.

On 23 July 1993, as part of a broader deal, COGEMA acquired all of the uranium assets of Total, and therefore became the sole shareholder of Minatco Ltd. In 1996, Minatco was amalgamated into COGEMA Resources Inc, who is operator of the McClean Project [1].

The resulting ownership structure of the McClean Joint Venture as of 1 January 1997 is:

COGEMA Resources Inc	70%
DENISON Mines Limited	22.5%
OURD (Canada) Cy Limited	7.5%

3. REGIONAL GEOLOGY (Fig. 2)

The McClean area straddles the transition zone between the Mudjatik Domain to the west and the Wollaston Domain to the east, the latter hosting most of the major uranium deposits of Saskatchewan. Approximately one half of the area is underlain by Archean granitic basement rocks. These rocks occur as anticlinal domes and range from granitoids in the core to foliated granitoids, gneissic rocks and migmatites on the margins. Mineralogy consists essentially of quartz-feldspar-biotite.

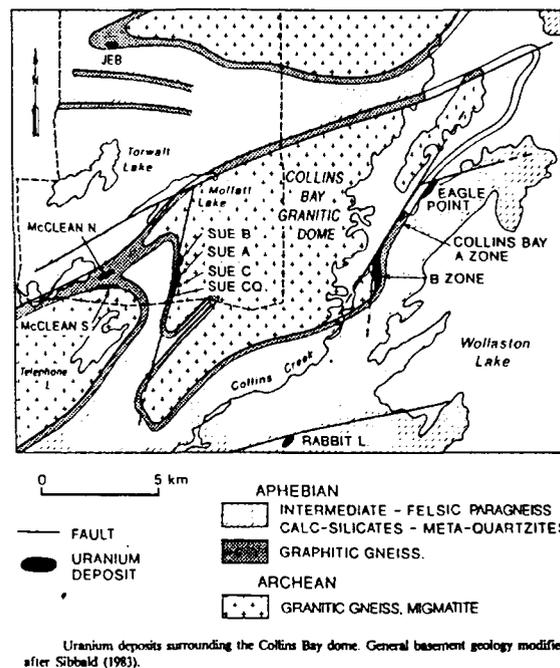


FIG. 2. Uranium deposits surrounding the Collins Bay dome. General basement geology modified after Sibbald (1983).

The granitic domes are unconformably overlain by a thin cover of Aphebian paragneissic rocks, 200 to 300 m thick. The lowermost succession of the Aphebian paragneiss cover contains one to several graphitic units. All the known uranium deposits on the property are associated with these graphitic gneisses.

The basement rocks are unconformably overlain by a flat lying Athabasca sandstone formation of Helikian age. The sandstone cover on the area varies in thickness from 0 to 200 m and is generally overlain by 5 to 30 m of Quaternary glacial till consisting of mixed sand, sandstone and basement boulders.

4. THE McCLEAN URANIUM DEPOSITS

The McClean Lake Project consists of five uranium deposits scattered in three different locations on the mineral lease. They are:

- Jeb in the north
- Sue A, Sue B, Sue C in the south
- McClean, a few kilometres west of the Sue group

These five orebodies are generally related to and positioned close to the unconformity contact between the Athabasca sandstone and the underlying metamorphic gneisses of the basement.

The JEB deposit

On average 18 m of glacial overburden covers the area of the JEB deposit.

Below this overburden a thickness of 75 m of Athabasca sandstone exists. These sandstones are generally quite competent but locally strongly faulted and clay enriched directly above the orebody.

The Aphebian units intersected at the Jeb zone include a package of graphic rocks (intermediate gneisses, calc-silicate gneisses, and pegmatoids) generally associated with the mineralization and non graphitic units flanking the orebody to the north and south. Structurally the Jeb zone is quite complex with no main system. Instead, a series of four systems, EW-NWSE-NESW and NS, interact together to both limit and offset the mineralization and create structural traps beneficial for high grade mineralization. Flat lying structures occur at Jeb and delineate zones of weakness with increased hydrothermal alteration and control the mineralization.

Two main types of mineralization exist at Jeb, the most common and the highest grade being that which straddles the unconformity at the sub-crop of the graphitic gneisses and pegmatoids. This mineralization occurs in the form of pitchblende and uraninite. Grades can be higher than 30% U_3O_8 .

The second type of mineralization is related to the shear cleavage developed 2-15 m below the unconformity. Grades are lower, but locally can be greater than 10% U_3O_8 . Significant amounts of nickel in the form of arsenides and sulphoarsenides are dispersed throughout the orebody but also concentrated in the southern flank of the mineralization. The average grade of nickel associated to uranium is 1.0-1.5%.

The Sue A deposit

The Sue A deposit lies between 60 m and 75 m below surface and strikes N12°E. The deposit is 170 m long with a width averaging 15 m to 20 m. Its thickness varies from 1.5 m to 12 m with an average of 9 m. The mineralization is extensively controlled by faulting, resulting in irregular cross-sectional shapes. In general, the deposit is flattened with a westerly dip conforming to the down-dropping of the unconformity. Along strike, mineralization terminates against two sets of faults, northeast and northwest in direction.

The deposit lies on and immediately above the unconformity, in an envelope of massive earth-red clay. Argillic alteration extends almost up to the sandstone sub-crop along fault zones, leaving only scattered sections of silicification in the cap rock. An average of 9 m of glacial overburden covers the sandstones.

Minor amounts of uranium mineralization extend downward into the basement as narrow roots along faults. Less than 2% of the Sue A deposit lies below the unconformity.

The distribution of uranium is confined to a few high grade ($> 5\% \text{U}_3\text{O}_8$) pods, mostly in the south half of the deposit where some 70% of the total uranium is located [2].

The Sue B deposit

The Sue B deposits is located approximately 350 m north of Sue A. The mineralised zone is 90 m long and averages 40 m in width (Fig. 3) but unlike Sue A, the mineralization occurs within two different horizons in the sandstone. The upper horizon contains some 50% of the uranium mineralization. It lies at a depth of about 20 m above the unconformity. Mineralization extends at one point to the subcrop of the Athabasca sandstones, at a depth of 8 m below surface. This upper zone is about 50 m long, 26 m wide and 17 m thick. The lower zone of mineralization lies on and immediately above the unconformity at depths ranging from 60 m to 75 m. In general, the mineralization lies on the western flank of the basement high and follow the down-dropping in steps of the unconformity.

The Sue B mineralization is largely fault-controlled. The upper zone appears as a product of intersecting structures such as conformable and conjugate faults which created a zone of weakness and relatively high permeability.

The Sue B orebody is a medium grade deposit with very little high-grade mineralization. Grades usually do not exceed $5\% \text{U}_3\text{O}_8$ [2].

The Sue C deposit

The Sue C area lies immediately to the Southwest of the Sue A deposit. The Sue C mineralised vein is a 10 m to 15 m wide N12°E trending subvertical structure dipping 70 degrees to the east (Figs. 4 and 5), paralleling the Archean-Aphebian contact located 100 m to the east. The mineralised zone is 400 m long and averages 40 m in width.

The mineralization is hosted by reverse anastomosing faults, (the Sue C fault), striking N12°E, parallel to the basement lithologies. It is located at the footwall of the graphitic gneiss, in a clay-rich zone as well as in the lower graphitic unit itself. It is typically underlain in sharp contact by massive quartz or silicified paragneiss. A second silicified zone was intersected 30 m west of the ore.

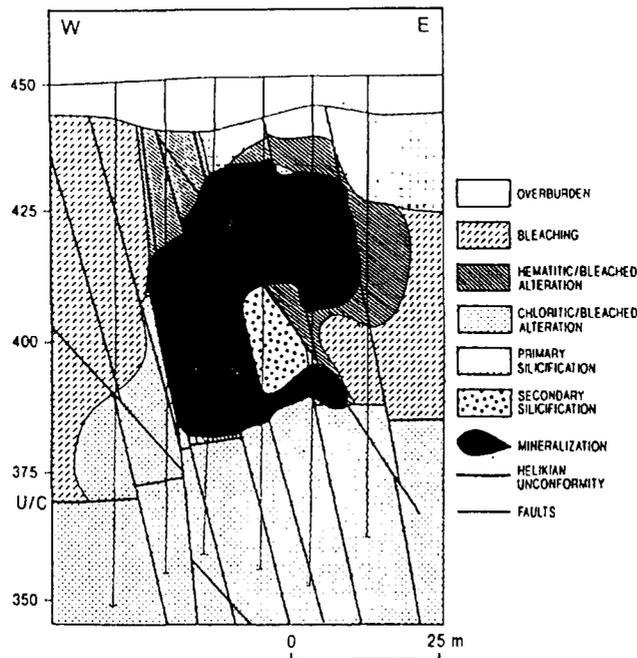


FIG. 3. Sue B deposit alteration pattern and contour of the mineralization at 500 ppm cutoff.

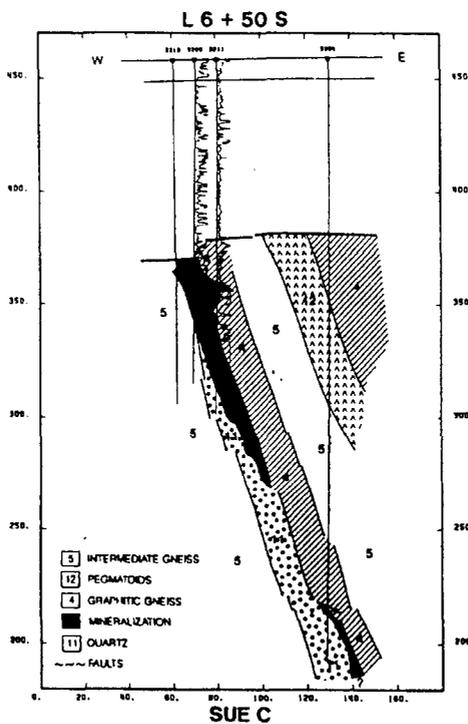


FIG. 4. Sue C deposit.

The mineralization consists of massive pitchblende, pitchblende nodules and veinlets within a white, black or blood-red clay envelope. The mineralization contains minor amounts of arsenides. At the scale of the deposit, the mineralization typically exhibits a vein geometry parallel to the remnant subvertical foliation. On a detailed scale, the high-grade pods are distributed as vertically stacked flat lenses. Therefore the main structural control of the mineralization is the concomitant action of steeply dipping faults and flat-lying shears.

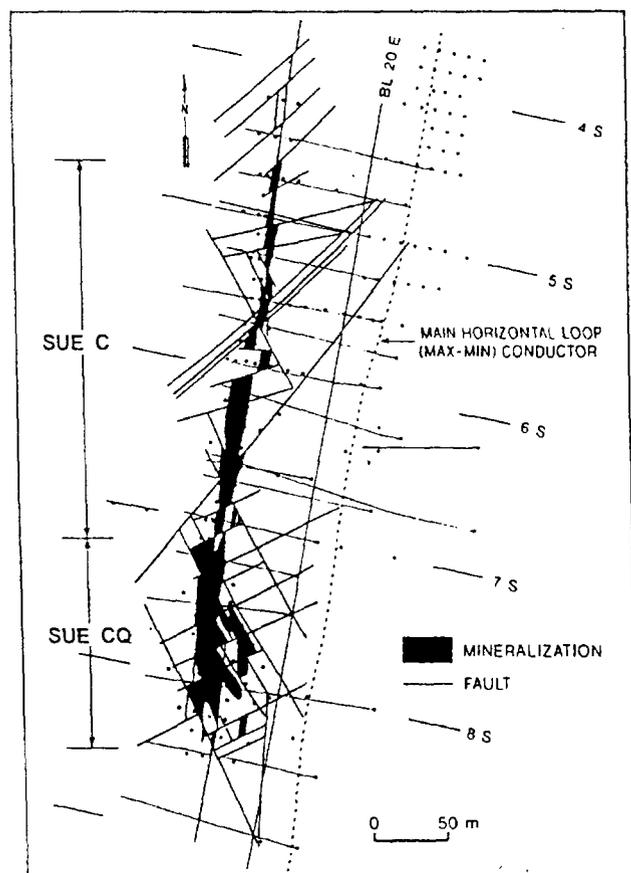


FIG. 5. Sue C — CQ deposits outline of the mineralization at 0.5% cutoff.

The flat-lying shears are associated with a thickening of the silicified zone at depth, thus controlling the downdip limit of the ore. The maximum depth of the mineralization ranges from 115 m in the north to 150 m in the south. The unconformity is typically located 75 m to 80 m below surface and is disrupted by major reverse faults creating a hump or offsets of up to 40 m. There is no evidence of the mineralization extending upward into the overlying sandstones. Immediately above the ore, the sandstones are strongly argillized (illitization and bleaching) with local hematization.

The continuity of the mineralization in the Sue C deposit is interrupted by major NE and NW faults which have slightly displaced the vein over a few meters. To the South (CQ) the mineralization is discontinuous and of lower grade. The ore is hosted completely within intensely altered graphitic to non-graphitic intermediate paragneiss. The overall mineralised volume is divided into multiple moderately dipping lenses for a total width of 40 m over a strike length of 125 m. The ore does not subcrop, the upper limit being a depth of 120 m, 45 m below the unconformity, and is known to date to a depth of 165 m, 90 m below the unconformity. The bulk of the mineralization consists mainly of pitchblende nodules associated with an ubiquitous red-brown hematitic clay-rich envelope [2].

The McClean deposit

A series of « pods » form two distinct deposits, the McClean North, 800 m long, and the McClean South, 500 m long (Fig. 6).

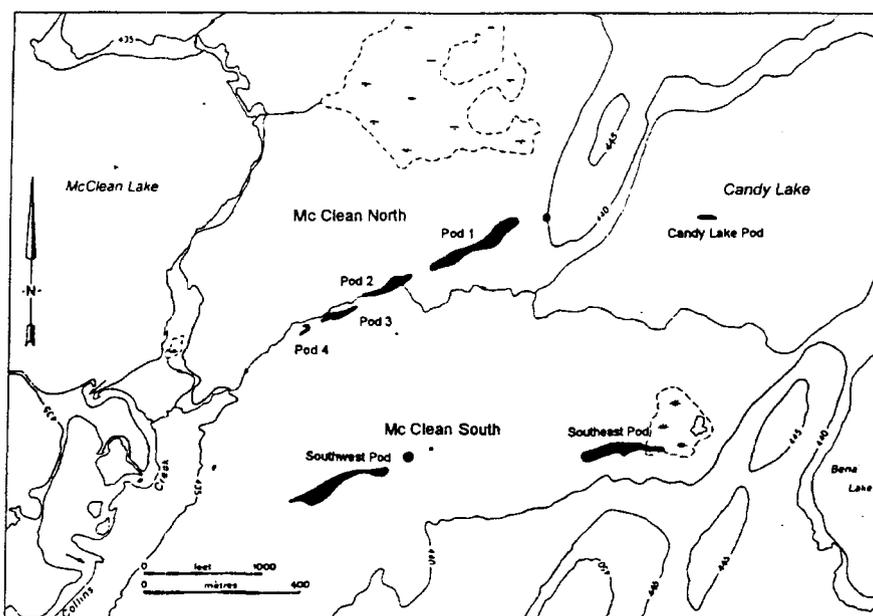


FIG. 6. McClean area — Uranium deposits.

The pods have a « sausage » shape and are 15-45 m wide, 8-25 m thick. The individual pods undulate about the sub-Athabasca unconformity, 40 m above to 40 m below. The unconformity is 170 m below surface. They form thin curved sheets rising from the east within the regolith to reach the unconformity where they thicken.

All the pods overlie graphitic units within the crystalline basement. Fractures and brecciation occur in the regolith and basement adjacent to mineralization, but some of these structures extend beyond ore.

The deposits consist of uranium and iron accompanied by relatively minor concentrations of As, Ni, Co, Cu.

5. RESERVES

The McClean mineral leases contain approximately 20 000 tonnes of uranium (50 million pounds equivalent U_3O_8) and there is a good potential for additional discoveries which would increase the figure significantly.

Mining reserves of the different deposits are given in the following table:

Deposit	Ore (tonnes)	Ore grade (%U)	U content (tonnes U)	Maximum depth (m)
JEB	71 850	2.79	2 003	110
Sue A	55 000	1.26	692	80
Sue B	90 100	0.73	654	80
Sue C	249 900	4.50	11 247	160
McClean	229 300	2.06	4 731	> 200
Total	696 150	2.78	19 327	

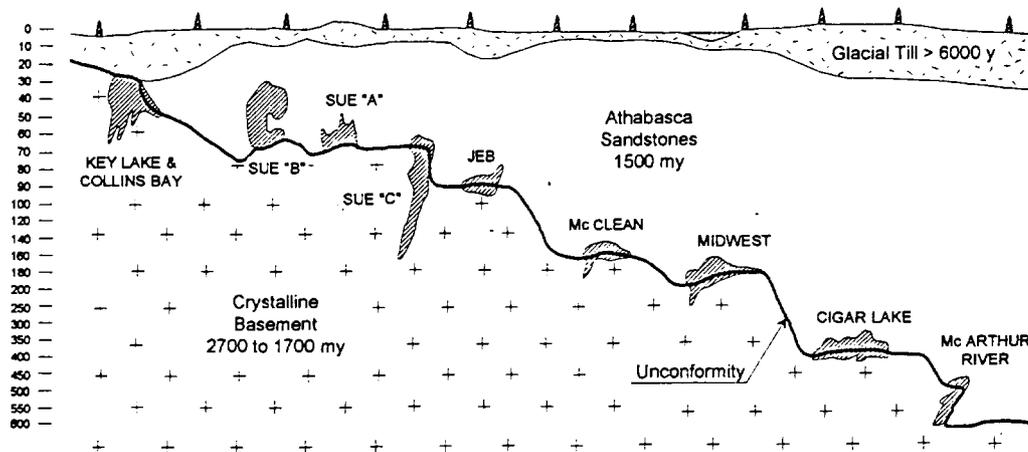


FIG. 7. Depths of known uranium deposits in the eastern Athabasca sandstone basin.

6. MINING

The depth of mineralization (Fig. 7) is obviously a major factor in the choice of the mining method: therefore JEB, Sue A, B and C will be mined by open pit methods. The McClean deposit consists of a series of mineralised pods at depths in excess of 170 m and will be mined from underground.

Stripping of the overburden on JEB deposit started at the end of 1995, followed in 1996 by waste rock mining. Ore mining is currently done and should be finished in August 1997. The ore is stockpiled. Mining activities will then move to the Sue deposits.

7. MILL

The McClean mill is located near the Jeb pit which will be transformed into a tailings depository during the second half of 1997 to receive the tailings from the mill.

The McClean mill has an annual capacity of 6 M lbs U_3O_8 (2300 t U). It will be increased to 24 M lbs U_3O_8 (9200 t U) to process 18 M lbs U_3O_8 from Cigar Lake. This mill will be the largest uranium mill in the world.

The different processes used at the McClean mill are rather conventional by today's standards. However, the mill has to process various categories of ore, originating from several ore bodies, some of them reaching grades up to 30% uranium. Effective radiation protection is therefore critical.

8. JEB PIT: WATER MANAGEMENT AND TAILINGS DISPOSAL FACILITY

The Athabasca Sandstone is completely saturated with water circulating in major fractures. Water inflows in mines, both open pits and underground, are generally large. After being collected in mine sumps and pumped, this water is contaminated and needs to be treated before release to the environment.

For this reason, a ring of 30 dewatering wells is being installed around the JEB pit, in order to intercept groundwater before mining. This water will generally be clean and can be directly

released to the environment. Total chemical loading to the environment will also therefore be reduced. In addition, the conditions for the mining equipment in the pit will be much dryer and better, resulting in lower maintenance costs.

These dewatering wills will continue to control the level of the water table when the pit is later operated as a tailing management facility. Thickened tailings will be deposited as a paste under water. This water cover will perfectly shield employees from radiation generated by the somewhat radioactive tailings resulting from the processing of high-grade ore.

9. CONCLUSIONS

The McClean Uranium project is the first new uranium mine developed anywhere in the world since Olympic Dam in South Australia in 1988. By the high quality of its reserves and the good potential for further discoveries this project will allow COGEMA Resources to fulfil its role as the COGEMA group's key producer in the « dollar » currency zone.

REFERENCES

- [1] POISSONNET, M., The new McClean Lake/Midwest uranium project. Uranium Institute 1995.
- [2] BAUDEMONT, D., PIQUARD, J.P., ZIMMERMAN, F.J., The Sue uranium deposits, Saskatchewan Canada, Exploration Mining Geology 1993.