Uranium market conditions and their impact on trends in uranium exploration and resource development

A review of historical developments and projections through the turn of the century

by Eberhard Müller-Kahle

The estimates for the growth of nuclear power made in the 1970s have been found to be overly optimistic. The reality accentuated by the accidents at Three Mile Island and Chernobyl has reduced these projections to a mere fraction of the original estimates.

This development has affected the nuclear fuel cycle industry, especially its sub-sector, the uranium resource industry, which occupies the first step of activities to produce fuel for nuclear reactors.

Most producers had to reduce uranium production, with the exception of Australia and Canada. Especially painful has been the reduction of revenues for the developing countries Gabon and Niger. Niger's economy depends to a large part on the revenues from uranium exports.

The following article reviews developments in the uranium market and its consequences for uranium exploration, and it outlines trends in exploration and uranium resource development.

Uranium market conditions

The current uranium market is mainly a reflection of several partly interconnected economic parameters: reactor-related uranium demand, supply, and uranium prices.

Uranium demand is based on nuclear electricity generating capacity, whose growth had been vastly overestimated in the past. For example, in 1975 this capacity was estimated to reach over 2000 gigawatts-electric (GWe) in the year 2000 for the World outside centrally planned economies area (WOCA). This was a low projection, translating into a demand of 244 000 tonnes uranium (tU).* This projection compares with the most recent estimates of 337 GWe and about 49 000 tU, approximately 20% of the 1975 projection.

In more detail, it is estimated that the uranium demand for WOCA increased from about 4000 tU in 1965 to 41 500 tU in 1989. This is equivalent to an annual growth rate of over 10%. The projection for the time through 2005 estimates a further, though smaller, increase to nearly 53 000 tU, or about 1.5% per year.

It is obvious that the difference between projection and reality of uranium demand had significant impacts on the uranium mining industry, which was undertaking efforts to supply the uranium needed for an ambitious nuclear programme. This process led to an oversupply of uranium through about 1984–85.

In 1965, uranium production totalled about 16 000 tU, compared to a demand of 4000 tU. Production increased to a peak of over 44 000 tU in 1980 and 1981, compared to a demand of about 30 000 tU. The overproduction through about 1985 led to a buildup of a uranium stockpile in WOCA, estimated to total 150 000 tU.** *(See accompanying figures.)*

The uranium industry's adjustment in the 1980s was very painful for mining companies and the countries where they operated. Total uranium production in WOCA declined from a peak in 1980–81 of over 44 000 t to about 34 000 t in 1989; it is now where it stood in 1978.

This development affected mainly producers in South Africa and the USA, where between 1980 and 1989 production declined by more than 50% to 70%, respec-

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* *Uranium Resources, Production, and Demand*, NEA (OECD)/IAEA, Paris (1986).

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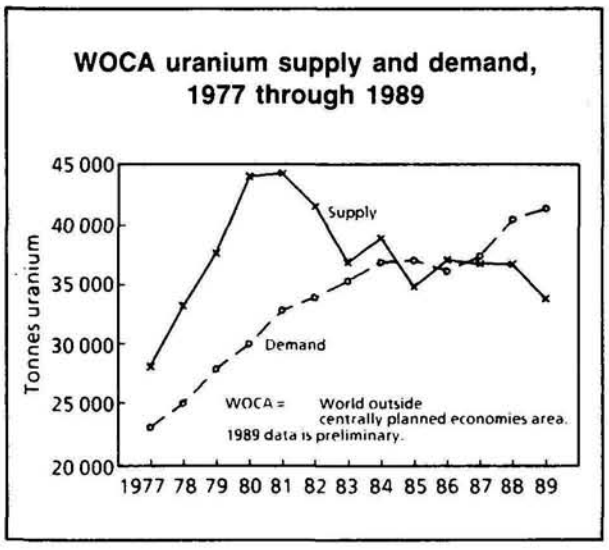
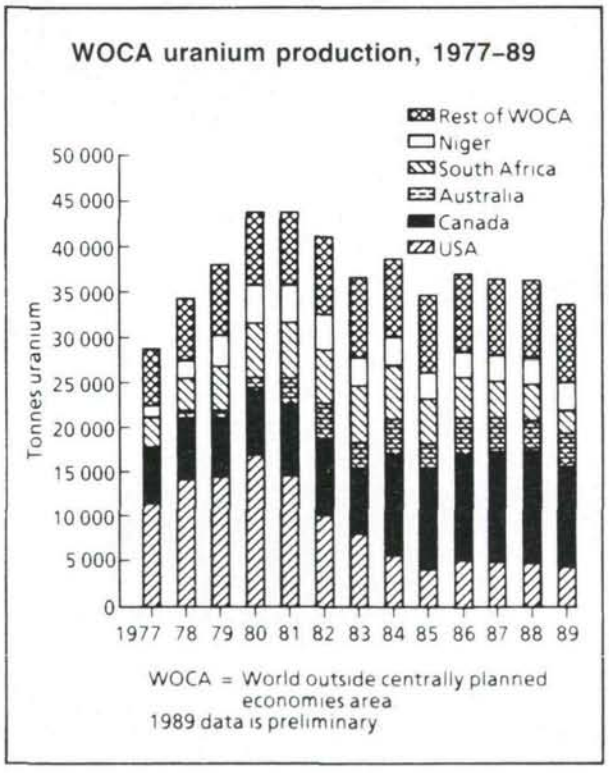




WOCA uranium production 1980 and 1989

	1980		1989	
	Tonnes uranium	Per cent	Tonnes uranium	Per cent
Australia	1 561	3.5	3 800	11.2
Canada	7 150	16.2	11 000	32.5
France	2 634	5.9	3 190	9.4
Gabon	1 033	2.3	950	2.8
Namibia	4 042	9.1	3 600	10.6
Niger	4 128	9.3	3 000	8.8
South Africa	6 146	13.9	2 900	8.5
USA	16 800	38.0	4 600	13.6
Rest of WOCA*	749	1.7	900	2.6
	44 243	99.9	33 940	100.0

Note: Data for 1989 is preliminary.

* World outside centrally planned economies area includes Argentina, Belgium, Federal Republic of Germany, India, Japan (1980), Pakistan, Portugal, Spain, Yugoslavia (1989).

tively. Other countries, including Gabon and Niger, had to make only smaller reductions of about 10% and 27%, respectively. However, Australia and Canada were able to increase their production by over 140% and 55%, respectively. *(See accompanying table.)*

Regarding the geographic concentration of WOCA's 1989 uranium production, three main producers (Canada, USA, and Australia) have a combined share of over 57%. Five main producers (Canada, USA, Australia, Namibia, and France) have a share of over 77%, and eight countries produce over 97% of WOCA's total.

In addition to the geographic distribution of WOCA's uranium production, the breakdown by major producing companies is interesting. Based on 1989 production, it is estimated that three companies (CAMECO, COGEMA, RTZ) produce over 40% and that eight companies (CAMECO, COGEMA, RTZ, Nufcor, ERA, Denison, Energy Fuels, and Uranerz Exploration and Mining) produce over 70% of the total.

The future effect of this concentration among a few producer countries and companies on the uranium market may be reduced competition and, consequently, rapid price increases where justified. For the first time in perhaps 15 years, the concern "that the supply side of the market might develop in the direction of a 'cartel'" was expressed in late 1989.*

The supply-demand projection for 1990–2005 is based on two supply scenarios. They refer to (1) the production capability of existing and committed mines and mills, which mine low-cost resources (recoverable at US $80/kg U or below); and (2) the expected production, which is assumed to be 80% of the production capability, as defined above.

For both scenarios, the increasing demand that is projected, from about 41 900 tU in 1990 to 52 900 tU in 2005, cannot be filled. The gaps in production capability increase from about 1000 tU in 1990 to over 20 000 tU in 2005. The cumulative gap is 135 000 tU, or 18% of the demand over this period. In turn, the gap for expected production is larger, totalling 250 000 tU, or 34% of the cumulative demand.

These gaps, however, do not represent supply deficits. This is because the large uranium inventories of both producers and consumers in WOCA are being used to fill this shortfall. Of the total WOCA inventory of

* "U prices not likely to gain next year, but eyes are on the mid-1990s", *Nuclear Fuel* (25 December 1989).

150 000 tU, about 70 000 tU exceed the amount needed for buffer stocks, and they are thus considered available as supply. In addition, there are uranium stocks in non-WOCA countries of unknown quantities. (Estimates, however, are in the range of a multiple of the available WOCA stocks.)

In both cases, stocks are probably increasing, as uranium used for defense purposes may be entering the civilian market. In view of this, it can be estimated that total stocks will be able to fill the production gaps projected through 2005 for both supply scenarios.

Thus, despite the production deficit, the uranium market is plagued with an oversupply of stocks. The consequences are a buyer's market, which would continue through the turn of the century, and a continuing pressure on prices.

As with other natural resources, such as oil and copper, there are two prices for uranium: the spot price for short-term deliveries and the contract price for longer-term deliveries. Also, the volume traded under these prices differ; the large majority of the material is traded under long-term contracts.

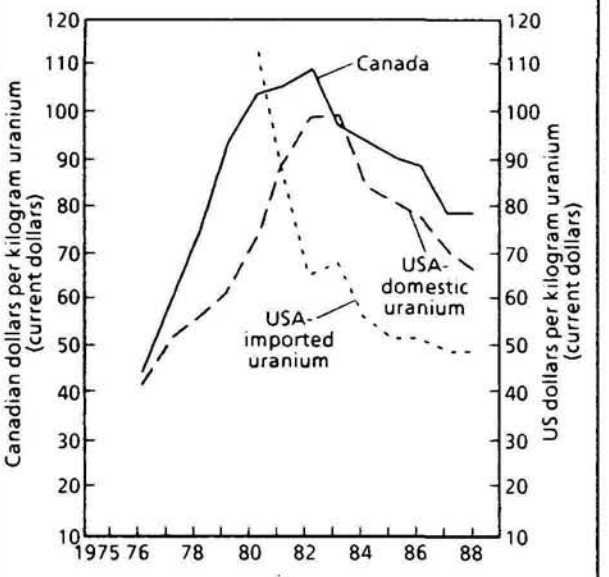
Trends in long-term uranium prices reflect the average export price of Canadian producers between 1970 and 1988, as well as the average price in the USA for domestic uranium (which from 1976 through 1981 includes minor amounts of imported material.) *(See accompanying figure.)* Looking at the trend, both prices increased from a level of about US $40/kg U in 1976 to a peak of US $100–110/kg U in 1981. The subsequent decline is not as drastic as it appears, having been dampened by high-price contracts concluded in the late 1970s. Nevertheless, both prices declined between 1981–88 to a range of between US $67 to US $80/kg U, or to about 70% of the 1981 high.

The spot price compiled by the brokerage firm NUEXCO, referred to as exchange value, shows a similar development. *(See accompanying figure.)* In current terms, the spot price increased from about US $16/kg U in 1972 to a high of about US $112/kg U in 1978. The drop started in 1979 and, with the exception of a small peak in 1983, continued through the end of 1989, when it reached US $26/kg U, or 23% of the 1978 peak.

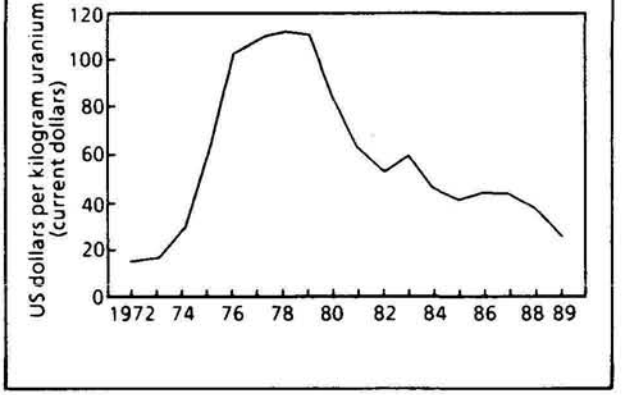
The future outlook for the uranium market will depend mainly on the uranium supply side. As long as large available inventories enter the market, there will be an oversupply, and consequently weak prices, especially as some of the material is sold regardless of price.

This will have further consequences on the mining industry, as more higher-cost producers may not be able to operate profitably under these market conditions. This situation may last through the turn of the century, unless nuclear power development increases unexpectedly.

Development of long-term uranium prices



Development of the NUEXCO spot price



Despite the complexity of the perceived future market, consumers do not appear to be concerned about assurance of future supplies, despite the concentration of supplies. This is suggested by available analyses of contracting strategies between 1984 and 1998 for 9-year periods (i.e. 1984–93, 1987–96, 1988–97, and 1989–98).

For both the initial and final years of these four periods, the contracted uranium as a percentage of the uranium demand declined. In the initial years, the amount decreased from 107% (over-contracting) of demand in 1984 to 80% in 1989. For the final years, the amounts decreased faster, from 51% of demand to 1993 to 32% in 1998.

* *Uranium Supply and Demand in the Western World*, Nukem Market Report 5 (1984), and *Contracted Natural Uranium Supply and Demand of the Western World*, Nukem Market Reports 12 (1986), 9 (1988), and 12 (1989).

Trends in uranium exploration and resource development

Exploration expenditures, which are considered a measure of activities, are largely a function of the uranium market's perception of resource adequacy to meet future demand. Such perceptions are reflected in uranium prices, one of them the well-documented spot price. *(See accompanying figure.)*

Total WOCA exploration expenditures refer to those expended *in* countries, while the foreign expenditures include those funds provided *by* certain (consumer) countries for searching for uranium resources in other countries.

In current money, total exploration expenditures increased from about US $80 million in 1972 to a peak of over US $750 million in 1979. Thereafter, they declined to about US $140 million in 1985, or to less than 20% of the peak expenditures. Since then, they have moved in a narrow range of between US $140–160 million per year.

Parallel to this adjustment is the geographical distribution of these expenditures. In 1979, a total of 40 countries reported exploration expenditures averaging about US $19 million per country, and in 14 countries exploration expenditures reached US $5 million or more. In 1989, however, a total of only 17 countries reported exploration expenditures averaging about US $7.5 million per country and in only four countries did these expenditures reach US $5 million or more.

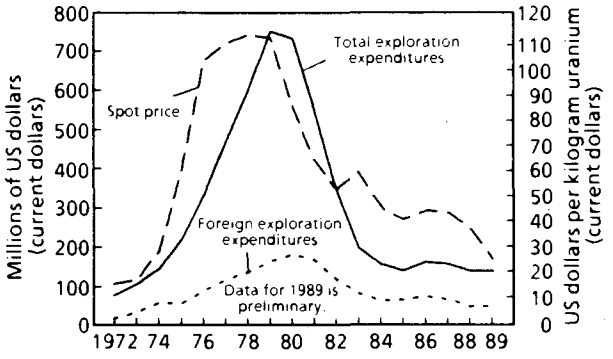
Developing countries have been especially affected by this development. In 1979, exploration expenditures were incurred in 23 developing countries, compared to only nine in 1989.

The five countries where uranium exploration has continued over the years are Australia, Canada, France, India, and USA. *(See accompanying table.)* This shows the importance of these countries for the future uranium supply. In 1979, the total amount spent in these countries represented more than 80% of WOCA exploration expenditures. In 1989, the share is expected to be more than 90%.

Developments in foreign exploration activities in WOCA, as previously explained, have followed a path similar to total expenditures. However, the contrast has not been as pronounced. In 1972, foreign involvement started with modest expenditures of about US $20 million and reached a peak of nearly US $180 million in 1980. They decreased to about US $60 million and then moved within a range of US $50-75 million.

As mentioned, funds for such foreign exploration activities are provided by mining companies based in countries with nuclear power programmes, mainly by France, Federal Republic of Germany, and Japan. *(See accompanying table.)* Three countries (Belgium, Spain, USA) terminated their foreign exploration projects somewhere between 1979 and 1989.

WOCA uranium exploration expenditures vs. NUEXCO spot price



Total and foreign uranium exploration expenditures, 1979 and 1989

	1979	1989 (expected)	Change (per cent)
Total expenditures			
Australia	33.0	10.0 (estimate)	-69.7
Canada	111.6	47.1	-57.8
France	61.2	40.7	-33.5
India	7.7	16.5	+114.3
USA	394.8	16.8	-95.7
Foreign expenditures			
France	52.3	10.9	-79.1
Germany, Fed. Rep.	30.0	13.2	-56.0
Japan	24.5	18.1	-26.1

Note: Expenditures expressed in millions of US dollars in current value.

Assessing both the total and foreign exploration expenditures in 1979 and 1989, the growing significance of uranium consumer countries becomes clear: in 1979, companies from France, Federal Republic of Germany, and Japan funded nearly 25% of all uranium exploration in WOCA. This share grew to 64% in 1989. It also becomes clear that foreign explorers concentrate the search for uranium in Australia, Canada, and the USA.

This is a significant change in the trend of uranium resource assessment from 1979, when exploration projects were carried out in a large number of countries in Africa and South America funded both nationally and internationally. The vast majority of these projects were "grass-roots" projects, based upon an incompletely known regional geology, which hypothetically could contain uranium deposits. Many findings were made,

but they would not be of economic value at current market conditions.

Therefore, following the decline of the uranium price in the early 1980s, uranium exploration became more concentrated. It was done in countries that combine a stable socio-economic climate with known uranium provinces containing deposits of high enough grade to be mined profitably under current market conditions. Examples for this concept include the East Alligator River region in Australia, the Athabasca Basin in Saskatchewan, Canada, and the Arizona "Strip" in USA.

Considering trends over the past 5 years or so, uranium exploration activities (including assessment of resources) generally are expected to continue in a mature uranium market, under the following conditions:

- as part of regional, multi-mineral resource assessments, which can also include integrated airborne surveys as currently being done or planned in Egypt, Indonesia, and Malaysia;
- as part of balanced nuclear fuel cycle and power programmes, as in the case of Argentina, Brazil, India, France, Federal Republic of Germany, Pakistan, among other countries; or
- when considering uranium only as an export product, if high-grade and/or low-cost deposits can be developed to compete with supplies from established producers.

As shown, uranium exploration tends to follow the uranium market's perception of resource adequacy to meet expected reactor-related demand. Given prevailing conditions, it is expected that uranium exploration expenditures will remain at a low level. This is despite the long lead times (12–15 years) from exploration through production.

However, with the decrease of uranium inventories to desired levels, and the subsequent tighter supply, prices will rise to such an extent that the uranium industry can expect appropriate returns on investment. Then a higher level of uranium exploration and resource assessment activities are expected to follow.

The present situation suggests that WOCA's uranium resource activities are likely to remain at low levels. This will be the case until the present oversupply is worked off and uranium prices rise sufficiently to cover the full costs of production, including a return on investment. This will induce further exploration and resource development.

The Yacimiento Cotaje uranium mine in Bolivia. (Credit: COBOEN)