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Cracks in the Ringwood solution

Dr Brian Martin evaluates the scientific claims made by Australian professor, Ted Ringwood, for his method for immobilising high level radioactive waste. Martin also evaluates the political statements made by Ringwood, based on the projected success of the method. Ringwood presents his research program as a solution to the barriers against uranium reprocessing and export, and to arms proliferation. The situation is critical considering the enthusiasm for the project in government circles, and the apparent absence of any form of peer review of Ringwood's claims.

Professor A E Ringwood, an eminent geochemist at the Research School of Earth Sciences at the Australian National University, in 1978 proposed a new method for dealing with high level radioactive waste generated by military or civilian nuclear reactors[1]. The essence of the proposal is to embed the elements of high level waste in a synthetic rock called Synroc with a crystalline structure able to hold these elements in place for millions of years. It is proposed that the Synroc will be encased in cannisters and buried deep underground in granite formations. Australia has some of the most suitable and stable rock formations in the world for such storage.

Ringwood has been very critical of other methods for disposing of high level radioactive waste, especially those based on glass, pointing to their technical shortcomings. Synroc promises to be a great advance over previously favoured methods, but there are criticisms which should be carefully considered.

Although radioactive elements have been held for millions of years in some natural rock crystals, this does not guarantee that this would occur in a synthetic rock with similar crystalline structures. To start with, Synroc contains a much higher percentage of the elements in radioactive waste than is found in natural rock. There have been no experimental tests of the longterm stability of rock crystals of the Synroc type. Natural rocks for the most part contain impurity elements which are *non*radioactive. Synroc will contain the radioactive varieties (isotopes) of these elements. Full testing has not yet been done with radioactive isotopes of the elements in radioactive waste. Therefore the physical changes in Synroc caused by radioactive decay over long periods of time remain to be determined.

One important example of an irradiation effect which promotes the breakdown of nuclear waste disposal materials by atmospheric moisture was identified in 1980 by E H Hirsch[2]. The radioactive disintegrations cause changes in the structure of the waste form. The surface eventually can become chemically sensitised, begin to react with water vapour and break down. This effect operates both in glass and in crystalline materials such as Synroc. The net effect is increased leaching of the waste disposal material. At the temperatures that Synroc will encounter this effect could be very serious.

In addition, natural rock is usually part of a large unified formation, whereas the Synroc would be disposed of only in relatively small portions in a granite formation whose natural integrity had been breached by the deep hole.

In summary, Synroc is as yet technically unproven. Furthermore, tests can never prove for sure — in advance — that a long term waste disposal method will be successful in practice.

These technical considerations must be considered in the context that even if Synroc were impregnable once synthesised and placed in the ground — and this remains to be shown — this would not solve the whole problem of radioactive waste.

The most environmentally sensitive time for radioactive waste is in the years *before* it is processed and entombed. Spent fuel rods from nuclear reactors are typically left in cooling ponds or other storage areas for years or even decades before reprocessing and disposal take place. During these years the waste is more highly radioactive than later, which indeed is why it is not disposed of sooner. If what is feared is release of radioactive elements to the environment by accident, natural disaster, terrorist attack or warfare, then this is where safeguards may still fail.

There is also no guarantee that Synroc or any other disposal method will be carried out correctly. There may be mistakes in synthesising

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Synroc, mistakes in choosing and drilling a disposal site and mistakes in filling and sealing the hole. Such 'mistakes' cannot be prevented through theoretical means since for the most part they arise from human error and lack of knowledge, as history has often proved. Since management of radioactive waste requires many thousands of years, the collapse of waste surveillance must be expected long before the waste becomes harmless, as surveillance depends on the survival of human institutions.

Much of the total human hazard from nuclear wastes arises from *intermediate* and *low level* wastes. These are not dealt with in the Synroc programme. It would be impossibly expensive. Low level waste is found for example in the once-used protective clothing worn by workers in the nuclear industry. Intermediate and low level wastes are generally dealt with in less secure ways. Example are land-fill burial, and dumping in the sea as proposed by the Japanese government.

The hazard from intermediate and low level waste should not be underestimated and neglected. A substantial fraction of long-lived radioactive elements such as plutonium end up in low level rather than high level waste[3]. Uranium tailings also pose a major radiation hazard. Although the radiation level at a given time is fairly low, the total human dose over the lifetime of the radioactive elements in tailings could be as great as for the rest of the nuclear fuel cycle combined.

Even if Synroc were technically flawless it would only constitute a partial solution to the problem of radioactive waste. Synroc cannot deal with the major problems of temporary storage of spent fuel, human error, and low level waste.

Since 1980 Ringwood has entered the public debate over the nuclear fuel cycle in a major way via public talks and articles. When presenting his arguments for Synroc, Ringwood presents persuasive arguments and musters considerable scientific evidence. When commenting on the export of uranium however, his case is much less rigorous. He presents no new arguments, and does not deal with many of the basic and long-standing objections.

Ringwood says that 'it really does not matter very much to other nations whether or not Australia withholds her uranium from the world market' since there are alternative sources of supply[4]. This claim is flawed by his neglect of the political factor.

The development of the nuclear fuel cycle does not depend simply on the economic availability of uranium and other materials. In most countries, nuclear power is an intensely political issue. Governments and some corporations have promoted nuclear power, while opposition has come largely from sections of the general population, such as from farmers in Europe and fishing communities in Japan. Essentially the struggle has been between, on the one hand, organisational interests in state bureaucracies, governments and corporations promoting nuclear power, and on the other hand popular opposition[5].

Withholding Australian uranium would be a major political action in the worldwide dispute over nuclear power and an immense boost for citizen opponents of the nuclear fuel cycle around the world. This is precisely why proponents of nuclear power want Australian uranium to be exported, even though it is not especially needed economically.

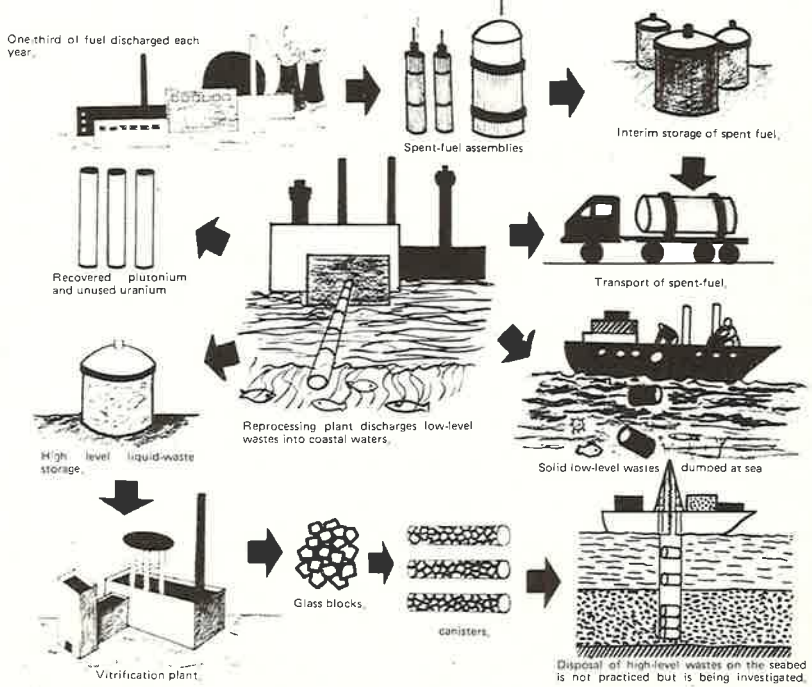
Nuclear weapons testing reveals a similar political dynamic. The French government prefers to test nuclear weapons in the Pacific because the political outcry would be too great if the weapons were tested in France itself. The same applies to uranium exports to France. Australian exports to France would not raise as much domestic opposition as would French acquisition of uranium from Gabon or from France itself.

Likewise, the New Zealand government's stand against visiting nuclear warships has no significant military impact, since the ships could just as easily stop at some other country. But the political impact of the ban is enormous, as shown by the outraged reaction of the US government.

Ringwood assumes that nuclear power on a world scale will be developed no matter what, and thus dismisses citizen opposition. But there is no inevitability to technological development. Just because the technology for nuclear or biological warfare, thought control or torture can be developed or even applied does not mean that these developments are desirable, inevitable or unstoppable. They have been and will continue to be opposed by many concerned people.

It is difficult to sustain the claim that participation in the nuclear fuel cycle would provide a real chance to influence the nuclear policies of other countries. Certainly there is no evidence that involvement in the arms trade, whaling or in selling pesticides has ever helped restrain the worst aspects of these activities.

In summary, Ringwood's support for exporting Australian uranium ignores the



The end of the nuclear fuel cycle

political impact that withholding uranium would have — a political impact both on citizen movements and on governments.

Ringwood favours the establishment of uranium enrichment and spent fuel reprocessing industries in Australia[6]. He claims that this would restrain the proliferation of nuclear weapons by ensuring that strict safeguards were imposed on the use of plutonium. He also cites the benefits of employment opportunities. None of these claims stand up to scrutiny.

Uranium enrichment and reprocessing, like uranium mining and nuclear power, are highly capital intensive operations and employment benefits would be minimal. Equivalent investment in manufacturing or services would create many times more jobs.

Ringwood fails to mention the disastrous technological and economic record of reprocessing plants[7]. For reprocessing of uranium oxide fuel, all major plants have either been shut down prematurely or run at a small fraction of planned capacity — or both.

Numerous inquiries and studies have shown the limitations of safeguards agreements as a means for preventing or restraining proliferation: the Ranger Inquiry in Australia, the Flowers Commission in the UK, the US Office of Technology Assessment, the Stockholm International Peace Research Institute, and the International Nuclear Fuel Cycle Evaluation. International Atomic Energy Agency safeguards, in which Ringwood puts his trust, have limited effect.

The Pakistan government, for example, is using facilities and skills acquired from its civilian nuclear program and from industrial espionage in a country complying with 'safeguards', in pursuing its nuclear weapons program. French officials have stated that they plan to use plutonium from the Superphenix breeder reactor — nominally a civilian facility — for its nuclear weapons program. And there are strong indications that the Brazilian and Argentine governments have moved closer to the production of nuclear weapons via their acquisition of civilian nuclear facilities. None of these or other relevant examples is mentioned by Ringwood.

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Nuclear wastes stored in German salt formations

Rather than helping restrain nuclear proliferation, enrichment or reprocessing in Australia probably would contribute significantly to it.

The introduction of the technology for uranium enrichment or for reprocessing into Australia on a commercial scale, along with the associated scientific and technological skills, would provide an avenue for acquisition of nuclear weapons by the Australian government[8]. Although Australian nuclear weapons are not now favoured by more than a minority in the government or military, this situation could change. The availability of the technological infrastructure and trained personnel for making nuclear weapons could be used by those favouring nuclear weapons as an argument to push for them.

This is not a hypothetical consideration. In the late 1960s a number of prominent politicians and scientists favoured the building of a nuclear power plant in Australia because it could be utilised for making nuclear weapons if desired. The leaked documents on 'The strategic basis for Australian defence', reported on in *The National Times* in March 1984, show that there is little principled opposition within the Cabinet or the policy-making elite of the Defence Department for the acquisition of Australian nuclear weapons.

Even if the Australian government did not plan or desire to use enrichment or reprocessing facilities for producing bombs, other governments might be worried about this possibility. Thus Australian enrichment or reprocessing could contribute to a regional nuclear arms race, especially with the Indonesian government.

Investment in the nuclear fuel cycle is a powerful incentive to continue those activities, even if they contribute to proliferation. Already there exist strong pressures to allow export of uranium to any purchasing country — such as South Korea and the Phillipines — irrespective of the potential for proliferaton.Since 1977, the Australian government's safeguards requirements have been watered down in a series of concessions made in order to obtain export sales. Far from Australian participation in uranium export helping to improve international safeguards, it is the safeguards which have been sacrificed to commercial pressures.

Rather than restraining the plutonium economy, investment in uranium enrichment or reprocessing would very likely accelerate its coming. Because of the high capital costs of nuclear facilities, once they are established they are likely to become entrenched[9]. This means that once heavy investments worldwide are made in thermal reactors, uranium enrichment and reprocessing, there will be enormous pressure to invest in breeder reactors — with their enormous potential for proliferation — in order to produce fuel for the thermal reactors.

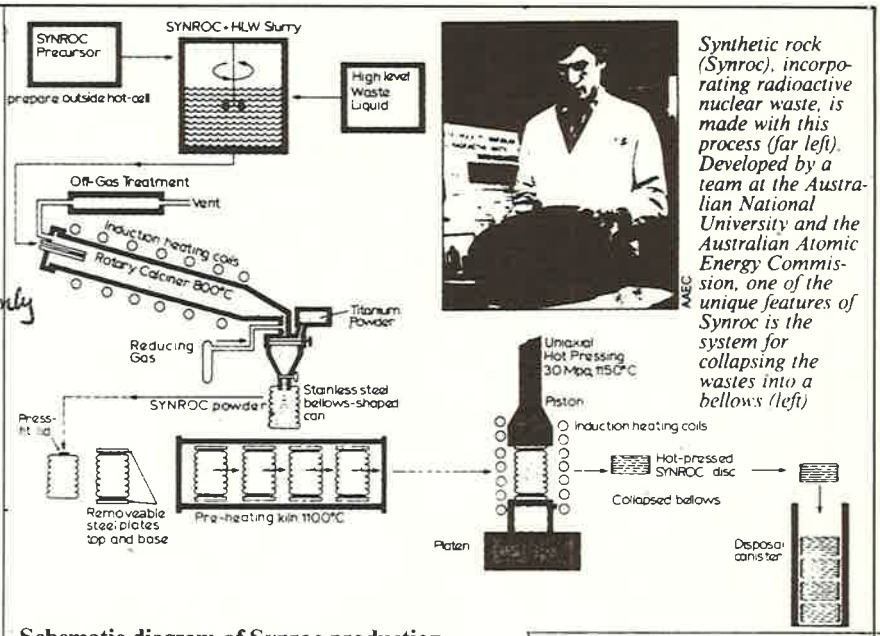
Enrichment or reprocessing would introduce another danger to Australia; the likelihood of attack in war. Precisely because of their potential for aiding nuclear weapons production, enrichment or reprocessing facilities would be prime targets in war. The Israeli military attack on an Iraqi reactor in June 1981 is indicative of the concerns generated by nuclear facilities. The environmental consequences of attack on a reprocessing plant would be immense, with much more long-lived radioactivity released than from a major nuclear explosion.

Contrary to Ringwood, uranium enrich-

ment or nuclear fuel reprocessing in Australia would more likely promote than restrain proliferation of nuclear weapons.

Ringwood says that there are only three major concerns about the nuclear fuel cycle: high level radioactive waste, nuclear reactor safety and proliferation of nuclear weapons[10]. This is a narrow view of the nuclear debate. There are many other important areas raised by critics of nuclear technology.

- As noted earlier, high level waste is not the only important waste. Also of concern are intermediate and low level wastes, including uranium tailings and nuclear reactors at the end of their economic life.
- There are other important environment concerns besides radioactive waste and reactor accidents. Some of these are the dangers of transporting nuclear materials, and health hazards to workers.
- The cost of nuclear power has greatly increased over the past decade. This is one major reason why nuclear power programs have slowed so much. This has especially been the case in the USA, where cancellations have exceeded new plants for the past decade. The USA is the one country where nuclear power has had to compete in the market with other energy sources. In most other countries nuclear power has simply been promoted by governments without much consideration to costs. Even in the USA there have been vast government subsidies to nuclear power.
- The promotion of nuclear power has been associated with attacks on civil liberties in many countries, due to nuclear power's links with nuclear weapons and the strong vested interests in the technology. The threat of terrorism or criminal use of nuclear materials provides another reason for restraints on civil liberties. In Australia, uranium mining was given the go-ahead under the repressive *Atomic Energy Act*. The introduction of uranium enrichment and reprocessing would very likely lead to further erosion of civil liberties. It is noteworthy that only in countries with authoritarian governments, such as the Soviet Union and South Korea, have nuclear programs proceeded relatively unchecked by citizen opposition — though even there economic and technological problems are serious. The French government, which is nominally democratic, has insulated its nuclear program from public scrutiny and involvement, and run roughshod over citizen opposition.
- Uranium mining on or near Aboriginal land has had devastating effects on both the land and on the Aboriginal health and culture. Although some Aborigines favour uranium mining — mainly due to the royalties they are receiving — many still oppose it. The Fraser government simply overruled the possibility of an Aboriginal veto of uranium mining, so it is not surprising that many Aborigines have acquiesced. That does not mean the consequences are excusable.
- Nuclear power is not needed as an energy source: it only supplies a few percent of the world's energy at the moment. Reserves of fossil fuels are more than sufficient to bridge a transition to a sustainable and environmentally benign energy future.
- Third World peoples do not need nuclear power. The poorest people — the vast majority — do not even have power points to use electricity. Nuclear power in Third World countries mainly benefits the rich in those countries. It also drains scarce foreign exchange, provides little employment where underemployment is a basic problem, and is used to help produce luxuries for the rich. Much more relevant to poor people are simple technologies, such as biogas for cooking, and programs for reafforestation.
- Experience during the past decade has demonstrated that the most cost-effective approach to energy problems is to increase the efficiency of energy use. In addition, there are many renewable energy technologies which are currently economically competitive or promise to become so in the near future.



Schematic diagram of Synroc production

Synthetic rock (Synroc), incorporating radioactive nuclear waste, is made with this process (far left). Developed by a team at the Australian National University and the Australian Atomic Energy Commission, one of the unique features of Synroc is the system for collapsing the wastes into a bellows (left)

Ringwood's presentation of the issues in the nuclear debate is seriously unbalanced. He downplays or ignores many important areas, especially the non-technical ones.

Professor Ringwood is to be congratulated for his efforts to find a safer method for disposing of high level radioactive waste. But scientific achievements do not impart any special validity to political views.

Ringwood's claims about the role of Synroc in overcoming the problems of radioactive waste are too sweeping. Synroc, *if* it is eventually proven to be as effective as hoped, will be a useful contribution towards treating existing nuclear waste. But even should this happen, it would not support the claim that waste disposal no longer is a major reason for opposing nuclear power. For Synroc does not overcome the problems of interim waste storage, of human error, or of low level waste.

Ringwood's views on proliferation are even more flawed. Uranium enrichment and spent fuel reprocessing, which he supports for Australia, would contribute to proliferation rather than restraining it. They would make Australian nuclear weapons more likely, contribute to a regional nuclear arms race, and provide a prime target in wartime.

Finally, Ringwood and other nuclear advocates have ignored or dismissed many of the most important aspects of the nuclear debate, including the effects of the nuclear fuel cycle on

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local Aboriginal populations, on civil liberties, and the possibility of doing without nuclear power by promoting energy efficiency and renewable energy technologies.

Ringwood's promotion of the nuclear fuel cycle is to be expected considering his career interest in promoting Synroc. Like other scientists who are nuclear advocates[11], he has a narrow view of the main problems of nuclear technology, ignoring or dismissing wider areas of concern. He focuses on technical fixes for problems which are fundamentally social, political and economic.

Decisions about nuclear technologies concern all members of the public. Much more debate and discussion is required before the Australian government can justify the allocation of large amounts of public funds to nuclear projects in this country.

Mark Diesendorf offered valuable comments on earlier versions of this article.

Notes

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