Nuclear Ontologies

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I

In October 2002, George W. Bush claimed that Saddam Hussein had "recently sought significant quantities of uranium from Africa." Pressed for details, his administration cited CIA intelligence that Iraq had tried to purchase 500 tons of uranium from Niger. Skepticism mounted, with the CIA itself expressing doubts about the intelligence. By the 2003 State of the Union address, senior officials instead credited the information to British intelligence. But the source mattered less, according to Bush, than the inescapable conclusion: Iraq planned to build nuclear weapons.

Since then, both the uranium and the weapons claims have been decisively refuted. In February 2002, the CIA sent former diplomat Joseph Wilson to investigate whether Niger had indeed concluded a deal with Iraq. Wilson found no trace of the alleged sale. When he heard Bush's statement a few months later, he initially assumed that the president meant some other uranium-producing African nation. Upon realizing that Bush really did mean Niger, an appalled Wilson went public in the *New York Times*. In an attempt to discredit him, an "anonymous source" from the Bush administration outed Wilson's wife as a CIA operative. Meanwhile, it turned out that the proof that Saddam sought uranium "from Africa" consisted of forged documents peddled by an Italian businessman. Most analysts now agree that there simply was no Iraq-Niger uranium deal.[1]

The re-emergence of this story in the media produced a cacophony of opinion, mostly pitting Bush stalwarts against defenders of Wilson. To the administration's obvious delight, bickering over personal credibility drowned out the pivotal issue of whether Bush misled the nation into war. It also bypassed the real significance of the Niger episode for contemporary global nuclear relations.

Consider the political and technical parameters of the administration's claims. Bush officials repeatedly stated that Iraq had sought uranium "from Africa." Had Saddam been suspected of approaching Kazakhstan, would they have asserted that he'd sought uranium "from Asia"? Highly unlikely. Africa remains the "dark continent," mysterious and politically corrupt – highly plausible qualifications for a nuclear supplier. And when details were required, what better candidate for shady dealings than Niger, a nation most Americans couldn't distinguish from Nigeria? Consider also the assumption that acquisition of "uranium" would constitute prima facie evidence of a bomb program's existence. In public discourse, "uranium" seems inseparably linked to nuclear weapons. But before "uranium" becomes weapons-usable, it must be mined as ore, processed into yellowcake, converted into uranium hexafluoride, enriched, and pressed into bomb fuel.

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"Uranium" is therefore as underspecified technologically as "Africa" is underspecified politically.

The Niger uranium episode draws attention to the ambiguities of the nuclear state, and to the state of being nuclear. What exactly is a "nuclear state," and how do we know? Are the criteria scientific, technical, political, systemic? The ambiguities underlying the episode cannot merely be dismissed as Bush administration doublespeak. On the contrary: they lie at the heart of today's global nuclear order – or dis-order, as the case may be.

From 1945, both cold warriors and their activist opponents cultivated the notion of nuclear exceptionalism. Atomic weapons were portrayed as fundamentally different from any other human creation. "The bomb" became the ultimate trump card; geopolitical status seemed directly proportional to the number of nukes a nation possessed. And nuclear exceptionalism – along with an accompanying rhetoric of rupture – went well beyond geopolitics. "Nuclear" scientists and engineers gained prestige, power, and funding far beyond their colleagues in "conventional" research. Anti-nuclear activists argued that nuclear technologies posed qualitatively and quantitatively distinct, never-before-encountered dangers. The fact that "going nuclear" involved splitting atoms – creating rupture in nature's very building blocks – only strengthened this exceptionalism. Asserting the ontological distinctiveness of "the nuclear" carried political, cultural, and economic stakes amplified by morality-talk, which tended to boil down to a simple duality: nuclear technology represented either salvation or depravity.

In Europe and North America, the simplifications of nuclear exceptionalism did not end with the Cold War. They merely shifted terrain, as the "clash of civilizations" replaced the "superpower struggle."[2] Once again, the discourse of exceptionalism crossed political boundaries. In 1990, left-wing intellectual Régis Debray opined that "broadly speaking, green [i.e., Islam] has replaced red as the rising force." This was especially frightening because "the nuclear and rational North deters the nuclear and rational North, not the conventional and mystical South."[3] On the right, Bush's "axis of evil" formulation escalated fears that nuclearity might escape the control of that "rational North."

Yet the "nuclear" has never been the exclusive province of "the North"; its tentacles have always wrapped around the globe. Consider uranium production. Uranium for the Hiroshima bomb came from the Belgian Congo. Britain's weapons program exploited imperial ties to uranium-supplying regions in Africa. Uranium reserves gave Australia and South Africa a material role in the "defense of the West." France's nuclear program depended on uranium in its African colonies.

Such a list could continue for pages. But many policy wonks would immediately raise an objection: by itself, they would say, uranium mining does not make a nation "nuclear." In 1995, for example, a major report by the Office of Technology Assessment with a summary of the "nuclear activities" of 172 nations did not list Gabon, Niger, or Namibia – which together accounted for nearly 25 percent of the world's uranium production that year – as having any "nuclear activities."[4]

Does this mean that uranium mines are somehow *not* nuclear? Can nuclearity, like radioactivity, be measured with a Geiger counter? Working in uranium mines exposes miners to radiation. Usually (though not always) they face lower exposure levels than workers in uranium enrichment facilities (whose nuclearity no one doubts). In the 1950s, Tandroy men worked small open-cast mines in Madagascar with hand tools. The ore they dug underwent only the most rudimentary treatment before shipment to France for refining and conversion. Tandroy miners themselves knew nothing of atom bombs, nuclear power plants, or radioactivity. They certainly received some radiation exposure, but no one will ever know how much.[5] Were the Malagasy mines somehow less "nuclear" than the Ranger mine in Australia, which has been subject to intense political, social, and environmental scrutiny since 1975? Were all of these mines, in turn, less "nuclear" than the French conversion plant at Malvési, the European enrichment facility in Almelo, or the US weapons labs at Livermore?

Such questions are problems of ontology, not merely of rhetoric. The *nuclearity* of a nation, a program, a technology, or a material – that is, the degree to which any of these things counts as "nuclear" – can never be defined in simple, clear-cut, scientific terms. Rather, nuclearity is a technopolitical spectrum that shifts in time and space. It is a historical and geographical condition, *as well as* a scientific and technological one. And nuclearity, in turn, has significant consequences for politics, culture, and health. Degrees of nuclearity structure global control over the flow of radioactive materials; they constitute the conceptual bedrock of anti-nuclear movements; they affect regulatory frameworks for occupational health and compensation for work-related illnesses. This matter of degree is crucial; nuclearity is not an on-off condition. Nuclear ontologies have a history, and a geography.

We cannot understand the geography of nuclearity without taking into account another kind of geopolitical rupture-talk from the Cold War period: the discourse of decolonization. Less than three months after the US bombed Hiroshima, the United Nations charter became the first document of international law to refer to "the principle of equal rights and self-determination of peoples." In principle (though certainly not in practice), a new world order had emerged built upon a foundation of equality for all. Independence would free Africans and Asians from the shackles of white rule. Formerly colonized people could choose their leaders, pursue economic prosperity, educate their children, and join the global community as peers. New nation-states would serve the interests of their people, who for the first time would be citizens rather than subjects. Like those of nuclearity, these ruptures too were matters of morality: the 1948 Universal Declaration of Human Rights was construed as a moral leap forward for humankind.

Political leaders blended nuclear and postcolonial discourses about rupture and morality in a variety of ways. Postwar French and British leaders not only hoped that the atom bomb would substitute for colonialism as an instrument of global power; they also saw in it a means of preventing their own colonization by the superpowers. Consider this remark by Churchill's chief scientific advisor, Lord Cherwell, in 1951: "If we have to rely entirely on the United States army for this vital weapon, we shall sink

to the rank of a second-class nation, only permitted to supply auxiliary troops, like the native levies who were allowed small arms but no artillery." Or French parliamentary deputy Félix Gaillard that same year: "those nations which [do] not follow a clear path of atomic development [will] be, 25 years hence, as backward relative to the nuclear nations of that time as the primitive peoples of Africa [are] to the industrialized nations of today." Nuclear = colonizer. Non-nuclear = colonized. Africa remained the eternal site of, and metonym for, backwardness.[6]

For Europeans this act of technopolitical mapping had deep roots, extending the assumptions and practices of the "new imperialism" to the nuclear state and to the state of being nuclear. Colonial warfare rested on the assumption that different moral structures underlay the rules of war for battles between "civilized" nations and conflicts with "savages." Aerial bombing followed machine guns as tools of extermination. Its first victims lived in oases outside Tripoli (1911) and villages in Morocco (1913). Even as ecstatic prophets in Europe and America proclaimed the airplane's ability to ensure world peace, the RAF experimented with strategic bombing in Baghdad (1923) and the French bombarded Damascus (1925). For prescient science fiction writers, it was only a matter of time before atomic energy would follow suit. And in a Pacific war with virulent racial overtones, it did. Several hundred thousand Japanese became the first victims of the "white race's superweapon."[7] As the Atomic Bomb Casualty Commission industriously erected colonial scientific structures to study the explosions' aftermath,[8] the US and Britain had already begun to scour African colonies in a desperate bid to monopolize the magic new stuff of geopolitical power: uranium.

II

In 1953, "Atoms for Peace" signaled an emerging new form of nuclearity: atomic power plants. As the program morphed into the International Atomic Energy Agency, the atomic creed left space for post-colonial leaders to challenge the technopolitical geography of nuclearity asserted by the West. The Indians stepped in first, as Jawaharlal Nehru proclaimed nuclear development a fundamental building block of Indian national identity. During negotiations over the IAEA statute, Indian delegates raised a challenge. If representation on the IAEA Board of Governors relied solely on technical achievement and a Cold War East-West balance, they charged, the agency would only reproduce immoral global imbalances. Instead, qualification for Board membership should combine nuclear "advancement" with regional distribution.

In the end, India succeeded. A complex formula allocated five permanent IAEA Board seats to member states deemed the "most advanced in the technology of atomic energy including the production of source materials" globally, and another five according to geographical region.[9] Uranium producers in Eastern and Western bloc nations would rotate through another two seats, and "suppliers of technical assistance" would rotate through one seat. The ten final spots would be electively distributed among the eight IAEA regions. The resulting emphasis on "advancement" made the Cold War obsession with technological rankings a structural feature of the IAEA. But geography

and national history also mattered. The regional framework accommodated – even encouraged – post-colonial fantasies of nuclear nationalism.

But what would make a nation count as "most advanced in the technology of atomic energy including the production of source materials"? What were "source materials," and how significant a manifestation of nuclearity were they? In the half-century since these phrases laid the foundation for the global nuclear order, their meanings have been negotiated and renegotiated in treaties, contracts, and practices. A few examples of these ontological shifts are enough to glimpse the high stakes of nuclear exceptionalism.

Consider the role of apartheid South Africa, whose delegate was responsible for including "source materials" as an indicator of nuclear technological "advancement" in the IAEA statute. By 1956, contracts signed with the US and Britain had made uranium production vital to South Africa's economy.[10] Anticipating that the IAEA would play a central role in shaping the emerging uranium market, South Africa was determined to obtain a statutory seat on the Board. Because the apartheid state represented the very antithesis of the postcolonial settlement pursued by India, only by asserting a depoliticized, technical vision of nuclearity could South Africa hope to secure its seat.

When IAEA statute discussions took place in 1954–56, South African nuclearity was limited to uranium production, underwritten by a very small research program. This was an increasingly tenuous basis for a claim to superior "advancement," for in the mid-1950s the nuclearity of uranium was in flux. Prior to that, the uranium narrative went something like this:

- Uranium was the only naturally occurring radioactive material that could fuel atomic bombs. These, in turn, were a fundamentally new kind of weapon, capable of rupturing not only global order but the globe itself.
- Uranium was a rare ore. If the West could monopolize its supply, it could keep the Communist ogre at bay and make the world safe for democracy. The West therefore had to secure all sources of uranium around the world. Nothing mattered more.
- Uranium's crucial importance made it imperative to proceed as secretly as feasible. Geological surveys, actual and potential reserves, means of production, terms of sales contracts: state secrets one and all. And if uranium's nuclearity imposed secrecy, that secrecy in turn reinforced the ore's nuclearity. Uranium was the only ore ever subject to legislation specifically targeted at ensuring the secrecy of its conditions of production.

By the mid-1950s, however, it had become clear that while pitchblende (very high grade uranium) was rare, lower grades of ore were not. The stuff was everywhere. Meanwhile, the Soviets had plainly found their own sources. So Western monopoly of "source material" – if defined simply as raw ore – would be impossible. The challenge lay not in *finding* uranium ore, but in *processing* it to weapons-grade quality.

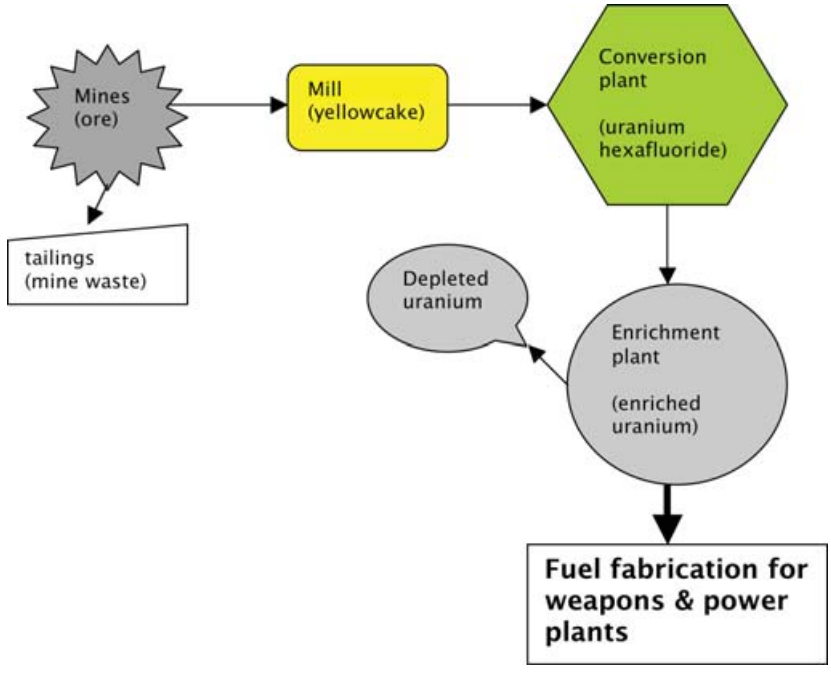
In IAEA statute discussions, one sign that the nuclearity of uranium ore had eroded was that nations whose primary claim to nuclearity lay in uranium production would have to rotate seats on the IAEA Board. Indeed, India tried to relegate South Africa and Australia to mere "producers" (rather than "most advanced" in their regions). Prevailing

on their powerful customers (the US and Britain) for support, South African delegates insisted that "source materials" should count as an indicator of "advancement."[11]

In terms of technological practice, South Africa was no more "advanced" in 1957 than, say, Portugal (which also mined uranium). The difference lay in technopolitical geography. Portugal was in Western Europe, a region at the pinnacle of nuclear "advancement." South Africa was in the IAEA's Africa/Middle East region, where its competitors for nuclearity – Israel and Egypt – carried political baggage even heavier than its own. In a technopolitical geography where the cold war trumped racial injustice, South Africa's uranium production could serve as the pinnacle of African nuclearity.

III

Matters of ontology also drove discussions about how to safeguard the nuclear order: how to control the flow of materials and technologies to ensure that instruments of planetary destruction didn't fall into the wrong hands. States not only had to agree on *how* to regulate, they also had to agree on *whom* and *what* to regulate. Who could be trusted with which systems? Which materials, knowledges, and systems were specifically nuclear? Of these, which were unique to atomic weapons and which were dual-use? It seemed understood that strongly nuclear materials or systems should be subject to stricter controls than weakly nuclear ones, but what did this mean in practice?



The uranium fuel cycle – front end

For example, "fissionable materials" clearly needed safeguarding. But what *was* a "fissionable material"? Uranium ore had to undergo milling, refinement into yellowcake, conversion to uranium hexafluoride, and enrichment before it could become fuel for nuclear reactors (or bombs). At exactly what point did uranium stop being "source material" and become "fissionable material"? The difference mattered enormously, because the two categories would be subject to different controls. In the words of one South African scientist, "the definitions would have to be essentially practical, rather than 'textbook' in nature, . . . legally watertight, and must take account of certain political implications." In the end, the IAEA definitions committee abandoned the more ambiguous term "fissionable material" (preferred by Indian delegates) in favor of three other categories: "source materials," "special fissionable materials," and "uranium enriched in the isotope 235 or 233."[12]

Exactly what would "safeguards" mean? Definitions alone didn't determine a method of control. The US promoted a pledge system in which purchasers of nuclear technologies and materials would agree not to use their purchases toward military ends, and accept international inspections verifying compliance. Most other nations *selling* nuclear systems paid lip service, at least, to controls on the flow of nuclear materials and technologies. Buyers, however, were underwhelmed by the prospect of controls. India, in particular, argued that regulating access would perpetuate colonial inequalities and undermine national sovereignty.

Neither side was completely disingenuous, but nor did these arguments tell the whole story. They obscured more mundane political and commercial issues. South Africa and Canada, for example, wanted to avoid controls on uranium end-uses which might put their product at a commercial disadvantage. Within India, experts and institutions disagreed over whether to build an atomic bomb, but wanted to keep their options open by minimizing international controls. Meanwhile, the US, the UK, and the Soviet Union refused to accept inspections of their nuclear installations. Western European nations accused the US and the UK of seeking competitive advantage, arguing that they too should be exempt from IAEA inspections, and be subject only to Euratom safeguards. Many "Third World" nations saw such arrangements as straightforward moves by the North to dominate the global South by writing the rule book in its own favor.[13]

The 1970 Treaty on the Non-Proliferation of Nuclear Weapons (NPT) expressed all of these tensions. Under the NPT, "nuclear weapons states" pledged not to transfer atomic weapons or explosive devices to "non-nuclear weapons states." The latter, in turn, renounced atomic weapons and agreed to accept IAEA safeguards and compliance measures. Strikingly, the NPT invoked human rights language and the rhetoric of development:

1. Nothing in this Treaty shall be interpreted as affecting the *inalienable right* of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes. . . .
2. All the Parties to the Treaty undertake to facilitate, and *have the right to participate in*, the fullest possible exchange of equipment, materials and scientific and

> technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also cooperate in contributing alone or together with other States or international organizations to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party to the Treaty, *with due consideration for the needs of the developing areas of the world*.[14]

In an effort to accommodate postcolonial morality and palliate the ascendancy of the Cold War paradigm, the NPT essentially declared that nuclearity – of the "peaceful" persuasion – was a fundamental right. It thus codified nuclear exceptionalism: no other international agreements referred to any scientific or technological activity as an "*inalienable* right" of special importance to "the developing areas of the world." And what the NPT codified, the IAEA implemented, via its program of "technical assistance" to developing nations.[15] This, incidentally, is the historical basis for Iran's current invocation of its "inalienable right" to nuclearity – and one reason why European negotiators found it legally impossible to deny that claim outright.

The NPT made nuclearity into a global "right," but it left the ontology of safeguards to the IAEA. Between 1961 and 1972, the IAEA produced five different documents, each with a somewhat different solution to the ontological problem of which materials and technologies were sufficiently nuclear to demand safeguards and inspections. By now South Africa had cemented the technological justification for its Board seat with an extensive nuclear R&D program, and wanted to minimize external oversight of its uranium industry. The nation led other uranium producers in continually, and successfully, pushing to exclude mines and ore-processing plants from official definitions. The 1968 safeguards document, for example, defined a "principal nuclear facility" as "a reactor, a plant for processing nuclear material, irradiated in a reactor, a plant for separating the isotopes of a nuclear material, a plant for processing or fabricating nuclear material *(excepting a mine or ore-processing plant)*. . . ."[16] Uranium mines and mills were thus specifically excluded from being nuclear in any way – even from the residual category of "other types" of "principal nuclear facilities." In 1972, uranium ore was specifically excluded, as well, from the category of nuclear "source material."[17]

By 1972, then, the nuclearity of uranium ore and yellowcake had plummeted. This fall from grace had concrete consequences. NPT signatories did have to inform the IAEA of yellowcake exports, but this did not trigger safeguards actions. No one was required to track yellowcake shipments or their fate, and uranium mines and mills were exempt from international inspection.

IV

The technopolitics of nuclear ontologies had fraught consequences in many other ways. For example, until the late 1960s the US Atomic Energy Commission refused to monitor working conditions in uranium mines and mills. In essence, the agency argued that mines were not really nuclear workplaces because, among other things, they did not

contain significant radiological hazards. A 1957 Public Health Service report categorically disagreed, finding high levels of radon gas in several Colorado Plateau mines.[18] Nonetheless, limits on radiological exposure in mines were not set until 1967, after extensive bureaucratic wrangling.[19] Subsequent developments reflected a peculiarly American admixture of nuclear exceptionalism and colonial politics. The 1990 Radiation Exposure Compensation Act (RECA) followed a decade-long struggle to compensate Navajo uranium miners. RECA payments — which ultimately were not limited to Navajos — were framed as "compassionate payments" to honor miners (and downwinders) who had sacrificed their health to the Cold War.

In South Africa, meanwhile, uranium did not count as a nuclear material for health regulatory purposes until 1999. Before then, South African mines implemented no special protections against radiological hazards, despite studies conducted in the 1950s, '60s, and '70s documenting extremely high radon levels in some shafts. The battle to bring mines under the purview of the National Nuclear Regulator lasted over ten years, and saw fierce resistance from the mining industry to the very principle of classifying any mine or plant as "nuclear."[20] Drawing on the appearance of good recordkeeping offered by apartheid-era systems of influx and labor control, mine operators argued that the workforce of black miners was so transient that no single individual could have received dangerous levels of radon exposure. In contrast, one well-placed South African radiation protection expert I interviewed estimates that thousands of miners multiplied their risk of cancer from two-fold to over ten-fold through radon exposure in the mines.

Until very recently, the principal ontological border of nuclearity for health purposes was the notion of the "permissible dose": the idea that below a certain threshold, health effects of radiation exposure are statistically negligible. Always controversial, this notion now seems conclusively refuted. A National Research Council report released in June 2005 concludes that there is "no threshold of exposure below which low levels of ionizing radiation can be demonstrated to be harmless or beneficial."[21] The regulatory consequences of this challenge to an established nuclear ontology remain to be seen.

Yet whatever they may be, they will certainly make waves in the virulent contemporary debate over the nuclearity of depleted uranium (DU) munitions, first deployed against Iraqi tanks in the 1991 Persian Gulf war and used again in the Balkans, Afghanistan, and the current Iraq war. Some scientists, activists, and former military personnel question DU munitions' legality as well as their morality. They emphasize the nuclearity of DU weapons, calling them "dirty bombs," "weapons of mass destruction" – or, at the extreme, "nuclear weapons." For them, DU's nuclearity has to do with its radioactivity, its persistent toxicity, and its effect on civilians living near places where DU munitions were used. Some activists have even coined a new term – "atomicity" – to designate the number of radioactive particles released; hence the much-quoted phrase "800 tons of DU is the atomicity equivalent of 83,000 Nagasaki bombs."[22] Nuclear nightmare narratives have resurfaced, ranging from reports of increased childhood leukemia rates in Basra to lurid accounts of horrifying birth defects among Afghani children and the babies of DU-exposed US veterans. The US and UK

governments – along with the IAEA and the WHO – downplay the nuclearity of DU weaponry and deny any proven causality between birth defects and DU exposure. At least until the recent NRC report, they asserted that the radiation levels released by DU munitions fall within permissible dose ranges, and would not cause discernible health effects.

Between these two extremes, a few challengers are seeking middle ground. "Atomicity" is meaningless and misleading as a scientific term, they argue, because it has "no regard for the type of radiation present, its relative biological impact, method of dispersal, etc."[23] At the same time they insist on the need for substantive data, maintaining that the Pentagon has failed to conduct appropriate research into the health effects of DU weapons, and even at times suppressed evidence.[24] Clearly the outcome of this debate – whatever it turns out to be – will have major effects on those caught in (nuclear?) battle in the future.

During the Cold War the amazing political flexibility of nuclear exceptionalism served to entrench it on the left and the right, in the North and the South. But the ontologies of nuclearity are ever-shifting. Global warming, Western fears about the impact of the alleged "clash of civilizations" on the world's oil supply (why we're really in Iraq), and Bush's bedroom relationship with the "nucular" industry are combining to transform nuclear power from ecological Satan to planetary savior – even James Lovelock, author of the Gaia hypothesis, is on board. South Africa is once again on the frontlines, with plans to design and build the first so-called "inherently safe" pebble bed reactor. This time its main partner is China, which intends to increase its nuclear power capacity five-fold by 2020. Iran, meanwhile, insists that its uranium enrichment program merely aims to guarantee access to nuclear electricity and ensure independence from the West. If nuclear power experiences the renaissance its promoters so deeply desire, what scheme will shape who gets to develop it, who only gets to buy it, and who doesn't get it at all? What will determine which technologies and materials are "safe"? And safe for or from whom? Anti-DU activists may not have the right answers, but they're asking the right questions. From Iran to North Korea, from the battlegrounds of Iraq to the suburbs of America – and yes, even in Niger – the stakes of nuclear exceptionalism remain high.

NOTES

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1. Iraq had acquired uranium from Niger, Portugal, and Brazil in the 1970s, when launching its nuclear program, but had stopped these purchases in the 1980s. Bush's claim did not refer to these earlier purchases. See Joseph Cirincione, "Niger Uranium: Still a False Claim," *Carnegie Proliferation Brief* 7, no. 12.
2. Samuel Huntington, *The Clash of Civilizations and the Remaking of the World Order* (New York: Simon and Schuster, 1996).
3. Régis Debray, *Tous azimuts* (Paris: Odile Jacob, 1990).

4. Office of Technology Assessment, *Nuclear Safeguards and the International Atomic Energy Agency,* OTA-ISS-615, April 1995, Appendix B.

5. Gabrielle Hecht, "Rupture-Talk in the Nuclear Age: Conjugating Colonial Power in Africa," *Social Studies of Science* 32, no. Nos. 5–6 (Oct.–Dec. 2002): 691–728.

6. Quotes in Alice Cawte, *Atomic Australia, 1944-1990* (Sydney: New South Wales, 1992), 41 and Gabrielle Hecht, *The Radiance of France: Nuclear Power and National Identity after World War II* (Cambridge, MA: MIT Press, 1998), 62.

7. Sven Lindqvist, *A History of Bombing* (New York: New Press, 2001); John Dower, *War Without Mercy: Race and Power in the Pacific War* (New York: Pantheon, 1986)

8. M. Susan Lindee, *Suffering Made Real: New York: American Science and the Survivors at Hiroshima* (Chicago: University of Chicago Press, 1994).

9. In 1956, members of the first category were the US, the USSR, the UK, France, and Canada; members of the second were South Africa, Brazil, Japan, India, and Australia. See David Fischer, *History of the International Atomic Energy Agency: The First Forty Years* (IAEA, 1997).

10. South Africa's uranium was located in the same mines that produced its gold. In the decade following WWII, supplying uranium to the US and Britain saved many of these mines from economic collapse and served as conduitsting for massive foreign investment in the nation's industrial infrastructure. See Thomas Borstelmann, *Apartheid's Reluctant Uncle: The United States and Southern Africa in the Early Cold War* (New York: Oxford University Press, 1993) and Jonathan E. Helmreich, *Gathering Rare Ores: The Diplomacy of Uranium Acquisition, 1943–1954* (Princeton: Princeton University Press, 1986).

11. "International Atomic Energy Agency," Annex to South Africa minute no. 79/2, 28/7/56. pp 10-11. National Archives of South Africa (hereafter NASA): BLO 349 ref. PS 17/109/3, vol. 2. The position of South Africa vis-à-vis the IAEA is thoroughly documented in the BLO 349, BVV84, and BPA 25 series of these archives.

12. Ibid. Plutonium fell into the category of "special fissionable materials." As a highly radioactive, extremely explosive, human-made material, it represented (and continues to represent) the pinnacle of nuclearity, the most exceptional of all things nuclear.

13. Lawrence Scheinman, *The International Atomic Energy Agency and World Nuclear Order* (Washington: Resources for the Future, 1987); Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State* (New York: St. Martin's Press, 1998); George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation* (Berkeley: University of California Press, 1999); Astrid Forland's "Negotiating Supranational Rules: The Genesis of the International Atomic Energy Agency Safeguards System," Dr. Art., University of Bergen, 1997.

14. Article IV of *The Treaty on the Non-Proliferation of Nuclear Weapons* (signed at Washington, London, and Moscow July 1, 1968). Emphasis mine. For the full text of the treaty, and the US State Department's triumphalist version of its history, see http://www.state.gov/t/np/trty/16281.htm.

15. Between 1958 and 1993, the IAEA gave out $617.5 million in "technical assistance." The top 10 recipients were Egypt, Brazil, Thailand, Indonesia, Peru, Pakistan, Philippines, Bangladesh, South Korea, and Yugoslavia. OTA, *Nuclear Safeguards and the International Atomic Energy Agency*, 53.

16. IAEA, INFCIRC/66/Rev.2, 16 September 1968.

17. IAEA, INFCIRC/153 (Corrected), June 1972.

18. Duncan A. Holaday et al, *Control of Radon and Daughters in Uranium Mines and Calculations on Biologic Effects.* Public Health Service Publication No. 494, (Washington: US Government Printing Office, 1957).

19. Eric W. Mogren, *Warm Sands: Uranium Mill Tailings Policy in the Atomic West* (Albuquerque: New Mexico University Press, 2002); J. Samuel Walker, *Containing the Atom: Nuclear Regulation in a Changing Environment, 1963–1971* (Berkeley: University of California Press, 1992).

20. This battle is extensively documented in archival material from the South African Chamber of Mines and the Council for Nuclear Safety.

21. See the press release on the National Academy of Sciences web site: http://www4.nationalacademies.org/news.nsf/isbn/030909156X?OpenDocument

22. Leuren Moret, "A death sentence here and abroad. Depleted uranium: Dirty bombs, dirty missiles, dirty bullets," Centre for Research on Globalisation, 8/21/04. http://globalresearch.ca/articles/MOR408A.html. Accessed 29 Sept. 2004.

23. Jack Cohen-Joppa, "Disinformation about Depleted Uranium," http://www.afsc.org/pwork/0411/041110.htm. Accessed 8 July 2005.

24. Dan Fahey, The Emergence and Decline of the Debate over Depleted Uranium Munitions, 1991–2004," 20 June 2004, posted on http://www.danfahey.com. Accessed 8 July 2005.

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